

<b>AWARD/CONTRACT</b>		1. THIS CONTRACT IS RATED ORDER UNDER DPAS (15 CFR 700)	RATING N/A	PAGE OF PAGES 1
2. CONTRACT NO. (Proc. Inst. Ident.) NRC-04-09-125		3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQUEST/PROJECT NO. 04-09-125	
5. ISSUED BY U.S. Nuclear Regulatory Commission Div. of Contracts Attn: Adelis M Rodriguez, 301-492-3623 Mail Stop TWB-01-B10M Washington, DC 20555		CODE 3100	6. ADMINISTERED BY (if other than item 5) U.S. Nuclear Regulatory Commission Div. of Contracts Mail Stop TWB-01-B10M Washington, DC 20555	
7. NAME AND ADDRESS OF CONTRACTOR (No. street, city, county, State and ZIP Code)  REGENTS OF THE UNIVERSITY OF MICHIGAN  503 THOMPSON ST  ANN ARBOR MI 48109-1340		8. DELIVERY <input type="checkbox"/> FOB ORIGIN <input checked="" type="checkbox"/> OTHER (See below)		
9. DISCOUNT FOR PROMPT PAYMENT  N/A		10. SUBMIT INVOICES ITEM (4 copies unless otherwise specified) TO THE ADDRESS SHOWN IN		
CODE 133209549 FACILITY CODE		11. SHIP TO/MARK FOR U.S. Nuclear Regulatory Commission  Washington DC 20555		
12. PAYMENT WILL BE MADE BY Department of Interior / NBC NRCPayments@nbc.gov Attn: Fiscal Services Branch - D2770 7301 W. Mansfield Avenue Denver CO 80235-2230		CODE 3100		
13. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION: <input type="checkbox"/> 10 U.S.C. 2304(c) <input checked="" type="checkbox"/> 41 U.S.C. 253(c)(1)		14. ACCOUNTING AND APPROPRIATION DATA BR 96015171277; JC N6694; BOC 252A; APPN 31X0200.960 FFS RES-C09-741; OBLIGATION \$55,000 DUNS: 073133571		

15A. ITEM NO.	15B. SUPPLIES/SERVICES	15C. QUANTITY	15D. UNIT	15E. UNIT PRICE	15F. AMOUNT
SEE SECTION B FOR A DESCRIPTION OF SERVICES THIS IS A COST REIMBURSEMENT TYPE CONTRACT  PROJECT TITLE: "PARCS DEVELOPMENT, MAINTENANCE AND ASSESSMENT"  PERIOD OF PERFORMANCE: five years from award date					

15G. TOTAL AMOUNT OF CONTRACT 51,485,682.  
16. TABLE OF CONTENTS See Attached Table of Contents

(X)	SEC.	DESCRIPTION	PAGE(S)	(X)	SEC.	DESCRIPTION	PAGE(S)
PART I - THE SCHEDULE				PART II - CONTRACT CLAUSES			
X	A	SOLICITATION/CONTRACT FORM		X	I	CONTRACT CLAUSES	
X	B	SUPPLIES OR SERVICES AND PRICES/COSTS		PART III - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACH.			
X	C	DESCRIPTION/SPECS./WORK STATEMENT		X	J	LIST OF ATTACHMENTS	
X	D	PACKAGING AND MARKING		PART IV - REPRESENTATIONS AND INSTRUCTIONS			
X	E	INSPECTION AND ACCEPTANCE		X	K	REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERORS	
X	F	DELIVERIES OR PERFORMANCE		X	L	INSTRS., CONDS. AND NOTICES TO OFFER	
X	G	CONTRACT ADMINISTRATION DATA		X	M	EVALUATION FACTORS FOR AWARD	
X	H	SPECIAL CONTRACT REQUIREMENTS					

CONTRACTING OFFICER WILL COMPLETE ITEM 17 OR 18 AS APPLICABLE

17. <input checked="" type="checkbox"/> CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return 1 copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award/contract, (b) the solicitation, if any, and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.) <b>Timothy P. Slotow</b> Executive Vice President & Chief Financial Officer	18. <input type="checkbox"/> AWARD (Contractor is not required to sign this document.) Your offer on Solicitation Number including the additions or changes made by you which additions or changes are set forth in full above, is hereby accepted as to the items listed above and on any condition sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your offer, and (b) this award/contract. No further contractual document is necessary.
19A. NAME AND TITLE OF SIGNER	20A. NAME OF CONTRACTING OFFICER Stephen Jobl Contracting Officer
19B. NAME OF CONTRACTOR BY <i>[Signature]</i>	20B. UNITED STATES OF AMERICA BY <i>[Signature]</i>
19C. DATE SIGNED SEP 25 2009	20C. DATE SIGNED 9/25/09

AUTHORIZED FOR LOCAL REPRODUCTION Previous edition is usable  
STANDARD FORM 26 (REV. 4/2008) Prescribed by GSA - FAR (48 CFR) 53.214(a)

TEMPLATE - ADM001

SUNSI REVIEW COMPLETE

OCT 02 2009

ADM002

## Table of Contents

<b>PART I - THE SCHEDULE .....</b>	<b>A-1</b>
<b>SECTION A - SOLICITATION/CONTRACT FORM .....</b>	<b>A-1</b>
SF 26 AWARD/CONTRACT .....	A-1
<b>PART I - THE SCHEDULE .....</b>	<b>B-1</b>
<b>SECTION B - SUPPLIES OR SERVICES AND PRICE/COSTS .....</b>	<b>B-1</b>
B.1 PROJECT TITLE .....	B-1
B.2 BRIEF DESCRIPTION OF WORK (MAR 1987).....	B-1
B.3 CONSIDERATION AND OBLIGATION--COST REIMBURSEMENT (JUN 1988) ALTERNATE I (JUN 1988).....	B-1
<b>SECTION C - DESCRIPTION/SPECIFICATIONS/STATEMENT OF WORK.....</b>	<b>C-1</b>
<b>SECTION D - PACKAGING AND MARKING .....</b>	<b>D-1</b>
D.1 PACKAGING AND MARKING (MAR 1987).....	D-1
<b>SECTION E - INSPECTION AND ACCEPTANCE.....</b>	<b>E-1</b>
E.1 NOTICE LISTING CONTRACT CLAUSES INCORPORATED BY REFERENCE.....	E-1
E.2 PLACE OF INSPECTION AND ACCEPTANCE (MAR 1987).....	E-1
<b>SECTION F - DELIVERIES OR PERFORMANCE.....</b>	<b>F-1</b>
F.1 NOTICE LISTING CONTRACT CLAUSES INCORPORATED BY REFERENCE .....	F-1
F.2 2052.211-70 PREPARATION OF TECHNICAL REPORTS (JAN 1993).....	F-1
F.3 2052.211-71 TECHNICAL PROGRESS REPORT (JAN 1993).....	F-1
F.4 2052.211-72 FINANCIAL STATUS REPORT (OCT 1999).....	F-1
F.5 DELIVERY SCHEDULE.....	F-3
F.6 PLACE OF DELIVERY--REPORTS (JUN 1988).....	F-3
F.7 DURATION OF CONTRACT PERIOD (MAR 1987).....	F-3
<b>SECTION G - CONTRACT ADMINISTRATION DATA.....</b>	<b>G-1</b>
G.1 2052.215-71 PROJECT OFFICER AUTHORITY (NOVEMBER 2006).....	G-1
G.2 2052.215-77 TRAVEL APPROVALS AND REIMBURSEMENT (OCT 1999).....	G-2
G.3 2052.216-71 INDIRECT COST RATES-ALTERNATE 2 (OCT 1999).....	G-3
<b>SECTION H - SPECIAL CONTRACT REQUIREMENTS.....</b>	<b>H-1</b>
H.1 2052.209-72 CONTRACTOR ORGANIZATIONAL CONFLICTS OF INTEREST (JAN 1993)H-1	
H.2 2052.215-70 KEY PERSONNEL (JAN 1993) .....	H-3
H.3 MODIFICATION TO 2052.235-70 PUBLICATION OF RESEARCH RESULTS (OCT 1999)H-4	
H.4 2052.235-71 SAFETY, HEALTH, AND FIRE PROTECTION (JAN 1993).....	H-4
H.5 GOVERNMENT FURNISHED EQUIPMENT/PROPERTY - NONE PROVIDED (JUN 1988)H-4	
H.6 SEAT BELTS .....	H-4
H.7 Annual and Final Contractor Performance Evaluations.....	H-5
H.8 WHISTLEBLOWER PROTECTION FOR NRC CONTRACTOR AND SUBCONTRACTOR EMPLOYEES (JULY 2006).....	H-5
<b>PART II - CONTRACT CLAUSES .....</b>	<b>I-1</b>
<b>SECTION I - CONTRACT CLAUSES.....</b>	<b>I-1</b>
I.1 NOTICE LISTING CONTRACT CLAUSES INCORPORATED BY REFERENCE.....	I-1

I.2 52.216-7 ALLOWABLE COST AND PAYMENT (DEC 2002) .....I-2  
I.3 52.219-28 POST-AWARD SMALL BUSINESS PROGRAM REREPRESENTATION (APR  
2009).....I-6  
I.4 52.222-39 NOTIFICATION OF EMPLOYEE RIGHTS CONCERNING PAYMENT OF  
UNION DUES OR FEES (DEC 2004) .....I-7  
I.5 52.249-14 EXCUSABLE DELAYS (APR 1984) .....I-9  
I.6 52.217-8 OPTION TO EXTEND SERVICES (NOV 1999) .....I-9  
I.7 52.252-2 CLAUSES INCORPORATED BY REFERENCE (FEB 1998) .....I-9

**PART III - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACHMENTS.....J-1**

**SECTION J - LIST OF ATTACHMENTS .....J-1**

**PART I - THE SCHEDULE****SECTION B - SUPPLIES OR SERVICES AND PRICE/COSTS****B.1 PROJECT TITLE**

The title of this project is as follows:

PARCS DEVELOPMENT, MAINTENANCE AND ASSESSMENT FOR THE NEXT GENERATION  
NUCLEAR PLANT

**B.2 BRIEF DESCRIPTION OF WORK (MAR 1987)**

The objective of this contract is to obtain contractor support to aid in the development and assessment of the nuclear analysis capability required for the VHTR evaluation model that will be used for the NGNP. Specifically, the development work consists of the improvement of the PARCS-AGREE code for the analysis of gas-cooled reactors as well as its integration with other codes such as SCALE/AMPX and MELCOR. This contract also provides for application support for the steady-state and transient nuclear analysis of VHTR reactors.

**B.3 CONSIDERATION AND OBLIGATION--COST REIMBURSEMENT (JUN 1988) ALTERNATE I  
(JUN 1988)**

- (a) The total estimated cost to the Government for full performance under this contract is \$1,485,682.
- (b) The amount presently obligated by the Government with respect to this contract is \$55,000.00.
- (c) It is estimated that the amount currently allotted will cover performance through October 31, 2009.

STATEMENT OF WORK  
FOR CONTRACTOR TO PROVIDE  
PARCS DEVELOPMENT AND ASSESSMENT  
FOR THE NEXT GENERATION NUCLEAR PLANT

## I. BACKGROUND

It is anticipated that, in accordance with the Energy Policy Act of 2005, a license application for a very high temperature reactor (VHTR), which may be constructed at the Idaho National Laboratory (INL) in connection with the Next Generation Nuclear Plant (NGNP) Project, will be submitted for Nuclear Regulatory Commission (NRC) review and approval in 2003. The NRC is beginning to conduct the research necessary to help support the licensing review of this potential design application. Specifically, the agency has begun developing an independent analytical capability to confirm the safety analysis evaluation methods and safety analysis results for the VHTR design of the NGNP.

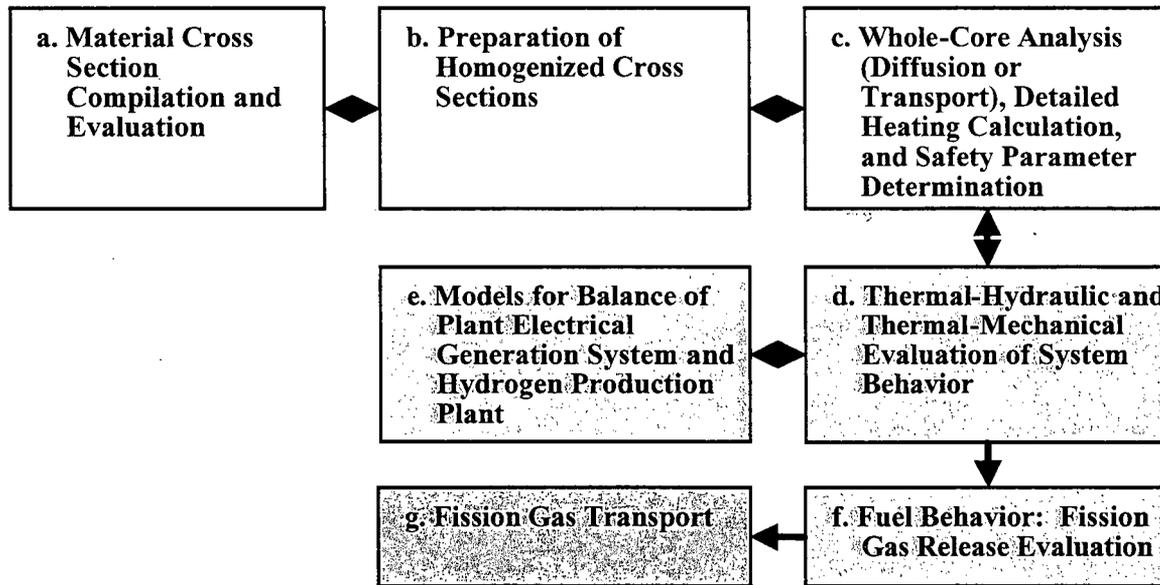
This independent analytical capability is embodied in an evaluation model (EM) that is based on the following definition provided in Regulatory Guide (RG) 1.203:

*'An evaluation model (EM) is the calculational framework for evaluating the behavior of the reactor system during a postulated transient or design-basis accident. As such, the EM may include one or more computer programs, special models, and all other information needed to apply the calculational framework to a specific event.'*

The purpose of this contract is to provide support to the staff to aid in the development and assessment of the nuclear analysis capability required for the evaluation model of a VHTR.

The development and assessment of such an EM was identified as a primary infrastructure need in the "Advanced Reactor Research Infrastructure Development Assessment" report. A validated EM will be needed to provide an adequate suite of reactor systems analysis tools (i.e., computer codes and methods) that provide the NRC staff with an independent capability to reliably predict VHTR system behavior and fission product release in response to initiating events. The NRC staff will use the suite of analysis tools, and the data to develop and validate them, to (1) conduct confirmatory analyses of a VHTR applicant's safety analyses, (2) support development of the VHTR regulatory requirements by assisting, for example, in better understanding the modeling of key accident phenomena and analyzing the performance of safety-related equipment during licensing-basis events, and (3) conduct sensitivity studies to better understand uncertainties and safety margins.

In general, the calculation process for the reactor system analysis component of a VHTR EM will consist of the seven steps depicted below:



For each step, one or more calculational models will be needed and two separate suites of codes may be needed to accommodate the two proposed VHTR designs: the prismatic modular reactor (PMR), and the pebble bed reactor (PBR). The steps depicted above fall into four categories:

- Nuclear Analysis,
- Thermo-Fluid Analysis,
- Fuel Behavior, and
- Fission Product Transport.

The scope of this contract is the development and assessment of the calculational tools required for nuclear analysis of a VHTR. The other analysis areas will be treated in other contracts and so require collaboration between contractors.

The nuclear analysis of a VHTR requires core analysis tools for (1) cross-section preparation and fuel assembly lattice calculations to produce effective nuclear parameters for subsequent whole-core analysis, (2) static reactor analysis for the determination of core operating conditions (power and temperature) including initial fission product inventory, (3) reactor kinetics and safety analysis, (4) evaluating the impacts of material-neutronics interactions on core design, (5) core heating and shielding calculations, and (6) decay heat calculations.

The primary nuclear analysis tools used by the NRC are:

1. The Purdue Advanced Reactor Core Simulator (PARCS) core neutronics simulator code
2. The Standardized Computer Analyses for Licensing Evaluation (SCALE) modular code system that includes a lattice physics code for neutron transport and depletion calculations in addition to a module for resonance processing, and

3. The AMPX code for processing the fundamental nuclear data in ENDF into code-usable libraries of continuous-energy or fine-group nuclear cross sections and related nuclear data.

The Office of Nuclear Regulatory Research (RES) has been developing the PARCS core neutronics simulator code since 1998. The SCALE/AMPX code suites have been developed in parallel through RES in-house work in collaboration with contract work at the Oak Ridge National Laboratory.

Both steady state and transient coupled reactor kinetics/thermo-fluid analyses will be required for the VHTR EM. Steady state core analyses will be performed by the PARCS- Advanced Gas Reactor Evaluation (AGREE)<sup>1</sup> code system. Transient coupled reactor kinetics/thermo-fluid analyses will be performed by the PARCS code coupled with the MELCOR system analysis code. For some transients, such as reactivity insertion due to control rod ejection, a more detailed thermal analysis of the core than can be performed by MELCOR is required for the coupled calculations. For such cases, the AGREE code will be used for the core thermal performance coupled to MELCOR for the system effects. Finally, for cross-section processing and lattice physics calculations, the SCALE/AMPX code suites will be used. Improvements to the SCALE/AMPX codes for VHTR analysis are being performed by ORNL under a separate contract. The scope of this contract considers the integration of the SCALE/AMPX code suites into an EM for gas-cooled reactors.

The application of the PARCS code to an advanced reactor design, specifically the VHTR gas-cooled reactor, and its integration into the associated EM give rise to needs for code development, assessment, and analysis support. These needs are briefly discussed below:

**Development:** Needs for code development arise in two ways: (a) the accuracy or functionality of existing code models is inadequate for an intended application, or (b) a code model required for an important phenomenon, process, or system is not available. The upgrade of existing modeling capabilities and the addition of new code models is particularly important as new advanced reactor designs are evaluated for licensing. Code development includes the provision of updated code documentation (i.e., theory manual, developer manual, user manual) as well as quality assurance testing to demonstrate code functionality.

**Assessment:** Code assessment provides the necessary qualification and validation of the codes for use in analyzing the safety of existing reactors and proposed new reactor designs. Code assessment establishes the technical basis for quantifying the expected accuracy and uncertainty of code predictions by means of testing the codes against a combination of code-to-code and code-to-data benchmarks that are applicable to the core design, operating conditions, and accident conditions of the reactor being analyzed. Especially important for assessing code accuracy are code-to-data benchmarks against applicable plant data, in-core data, experimental data from test reactors and/or critical

---

<sup>1</sup> AGREE is a three dimensional gas dynamics and heat transfer code developed by Seker and Downar and coupled with PARCS for the core analysis of gas-cooled reactors. See "Multiphysics Methods Development for High Temperature Gas Reactor Analysis," Ph.D. dissertation, Purdue University, December 2007.

facilities, and post irradiation data from fuel gamma scans, fuel isotopic assays, and fuel decay heat calorimetric measurements. Code-to-code benchmarks against similar or higher-order codes (e.g., exact-geometry continuous-energy Monte Carlo) further support the understanding of physical phenomena and modeling issues and the qualification of efficient code methods, modeling approximations, and analysis assumptions.

**Analysis support:** Continuing code analysis support and consultation is needed in various forms, potentially including but not limited to the provision of (a) on-the-job or formal code user training, (b) applied analysis assistance, (c) pre-analysis scoping studies, (d) experience-based technical insights and advice, (e) analysis knowledge management and preservation, (f) support for phenomena identification and ranking table (PIRT) processes, (g) analysis peer review, and (h) responses to questions and comments from code users.

## II. OBJECTIVE

The objective of this contract is to obtain contractor support to aid in the development and assessment of the nuclear analysis capability required for the VHTR evaluation model that will be used for the NGNP. Specifically, the development work consists of the improvement of the PARCS-AGREE code for the analysis of gas-cooled reactors as well as its integration with other codes such as SCALE/AMPX and MELCOR. This contract also provides for application support for the steady-state and transient nuclear analysis of VHTR reactors. Therefore, work that will be performed through this contract is essential to the agency's safety and efficiency strategic goals.

## III. SCOPE OF WORK

The scope of this contract is the development and assessment of the nuclear analysis capability required for these evaluation models. Specifically, the development work consists of the improvement of the PARCS-AGREE code for the analysis of gas-cooled reactors as well as its integration with other codes such as SCALE/AMPX and MELCOR. This contract also provides for application support for the steady-state and transient nuclear analysis of VHTR reactors.

## IV. REQUIREMENTS

The NRC evaluation model for VHTR reactors, as currently envisioned, is depicted below for pebble-bed and prismatic core gas-cooled reactors respectively. For all tasks, the contractor shall comply with code standards listed under Appendices A and B.

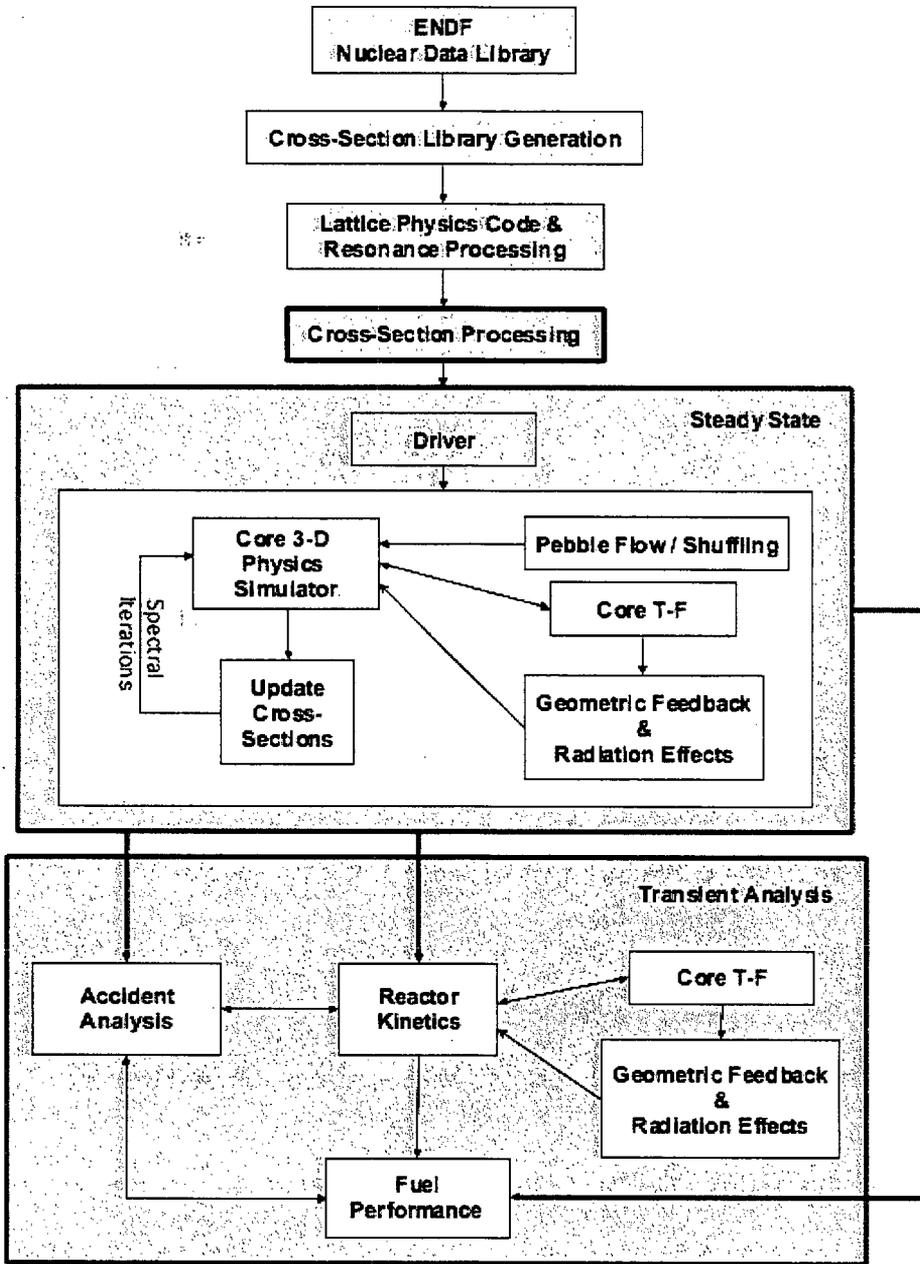
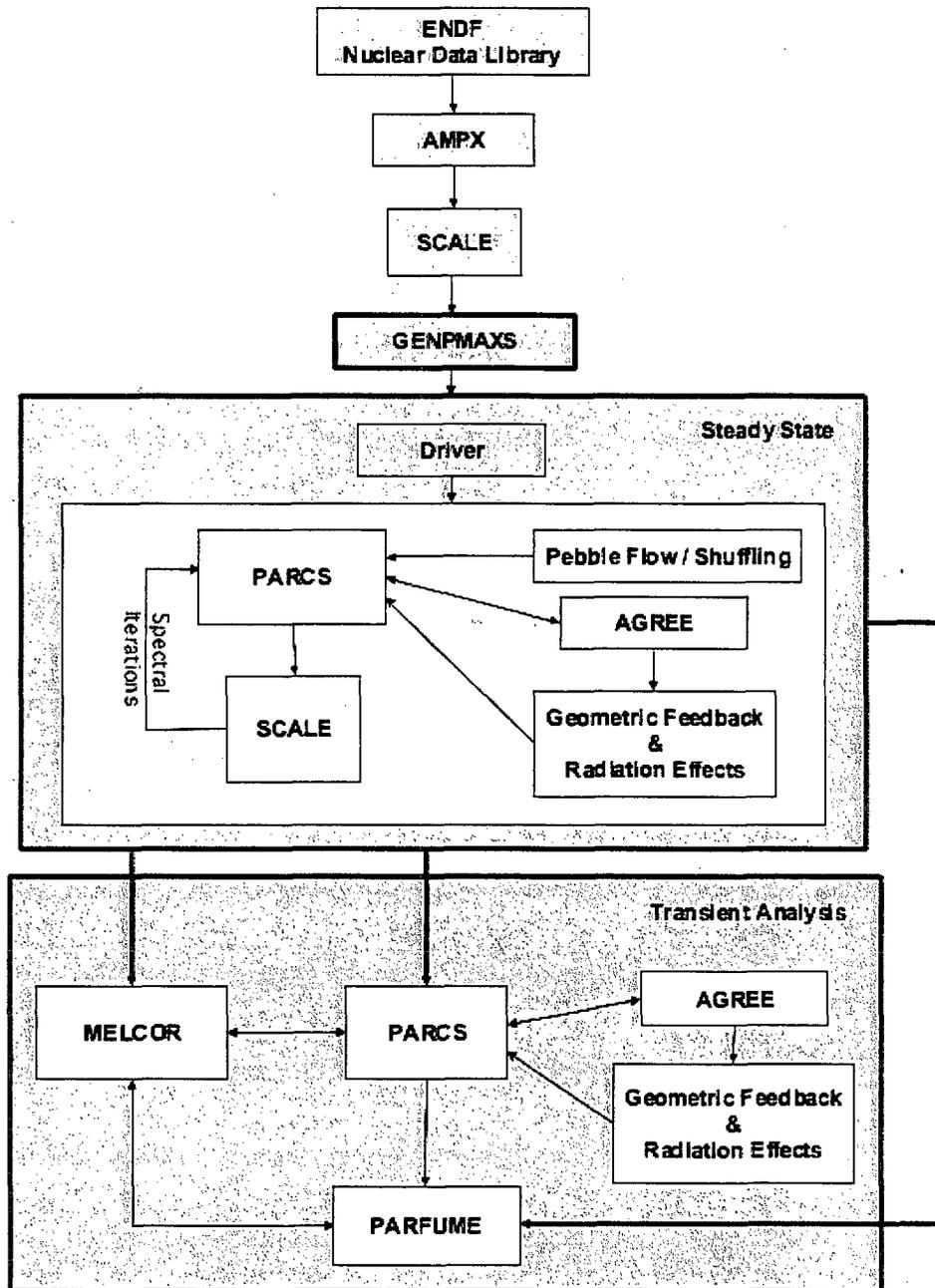


Figure 1: NGNP evaluation model with calculational components indicated by function.



**Figure 2:** NGNP evaluation model with calculational components indicated by name of the associated computer code where available.

### Task 1. PARCS Improvements for VHTR Gas-Cooled Reactors

The PARCS code was originally developed for the analysis of light-water reactors (LWRs), the dominant reactor type in the United States. It has been recently extended to include cylindrical coordinates (R- $\theta$ -Z) and Hexagonal-Z geometry options that allow for its application to PBRs and PMRs, respectively.

However, there are certain features of the proposed VHTR designs that require modifications to the available capabilities. For example, the physics characteristics of VHTR designs are quite different from those of the commercial LWRs because of the use of (1) an annular core design, (2) solid graphite moderator, (3) higher enrichment of the uranium fuel, (4) Tri-isotropic (TRISO) fuel particles, (5) helium gas coolant, (6) large temperature rise across the core, and (7) large holes for guiding control rods in fuel and radial reflector positions in prismatic VHTR designs.

### **Task 1.1 Development of PARCS Code Improvement Plan**

The contractor shall identify the improvements necessary to the PARCS code to render it an accurate and practicable core neutronics simulator for VHTR gas-cooled reactors. The recommended code improvements shall be transmitted to the NRC in the form of a letter report. Upon approval of this plan by the NRC project manager, the contractor shall begin the development work according to Task 1.2 below.

The proposed code improvement tasks should consider (but not be limited to):

- The heterogeneity effect arising from the use of the TRISO fuel particles (termed double heterogeneity effect).
- The VHTR core is neutronicly small due to the low neutron absorption in the graphite moderator (leads to a long mean free path for neutrons) and the annular core design. This poses a challenge to the neutronic codes which are based on homogenized few group constants. Consequently, more energy groups have to be used than for conventional LWR analyses, and multi-assembly or partial-core calculations might be needed for generating accurate homogenized cross sections and correction factors.
- The whole-core analysis tool should be able to model very accurately the core reactivity, flux and power distributions, accounting for the severe flux gradients and power peaking at the core and reflector interfaces of the annular core.
- Local neutron streaming effects arising from the large control rod holes in prismatic VHTR designs should be accurately represented.
- The core depletion state (including the nuclide number densities and core burnup distribution) should also be accurately predicted.
- Computational efficiency is needed in order to perform the large number of calculations required to support sensitivity and uncertainty analyses in a reasonable time. Investigate techniques such as Open MP to take advantage of the shared memory multi-core and multi-processor workstations.
- Microscopic Depletion Capability: the existing macroscopic depletion capability in PARCS inherently limits the accurate treatment of fuel depletion history effects for reactor physics analyses. There is an ongoing task to add a microscopic depletion capability to PARCS and to support it with the SCALE/TRITON lattice physics code. Modifications are needed to extend this capability to gas-cooled VHTR reactors.
- Update PARCS Flux Solver:

- Void Treatment: The diffusion equation is solved in the void regions with direction dependent diffusion coefficients. These coefficients are calculated by the method developed by Gerwin<sup>2</sup>. The applicability of the method to the annular upper cavities and side gap inside the reflector shall be verified.
- Improvement of Solution Kernel: Currently, the flux solution in PARCS is a fine mesh finite difference method. A very fine meshing is required to achieve a converged mesh resulting in significant increases in run time.
- The PARCS code currently uses the Triangular Polynomial Nodal Method (TPEN) for hexagonal geometries. This method has been extensively tested and benchmarked for the LWR. Modifications and validation of TPEN for the PMR is needed.
- Special purpose modules: Assess the INL modules to treat Geometric Expansion/Radiation Annealing Effects for the PBR and PMR and, as necessary, modify them for incorporation into PARCS.

Deliverables	Completion Date
Letter report documenting recommended PARCS code improvements for gas-cooled VHTRs.	1 month after award

### Task 1.2 PARCS Code Improvements for VHTR Gas-Cooled Reactors

Upon concurrence by the NRC project manager of the development plan from Task 1.1, the contractor shall perform the code development for the agreed-upon improvements. A milestone schedule for these individual development tasks will be generated and used to evaluate the timeliness of the contractor's performance. The contractor shall comply with code standards listed under Appendices A and B. Also, upon completion of each development task, the contractor shall update the PARCS theory and user manuals to keep the documents current with the source code.

Deliverables	Completion Date
Milestone schedule for agreed upon development tasks.	2 months after award
Updated PARCS Source Code.	24 months after award

### Task 2. Improvements to GENPMAXS

GENPMAXS is a code that uses the output of the SCALE code to generate cross-sections in the PMAXS format for usage by PARCS. Under sponsorship of the NRC, the GENPMAXS code

<sup>2</sup> H. Gerwin and W. Sherer, "Treatment of the Upper Cavity in a Pebble Bed High Temperature Gas-Cooled Reactor by Diffusion Theory," *Nuclear Science and Engineering*, 97, pp 9-19, 1987.

has been well qualified for the LWR, and all the functionality is currently in place to handle VHTR-specific feedback. Three subtasks shall be performed to improve GENPMAXS for application to VHTRs. Specifically:

1. Software Quality Assurance (SQA) of SCALE to PARCS coupling for the VHTR. This SQA would be relevant for both the PBR and the PMR designs.
2. Spatial Heterogeneity Effects Boundary Treatment in PBRs. Both the PBR and PMR have multiple heterogeneities that must be treated in order to properly account for resonance self-shielding effects. In previous work, INL implemented the work of Kloosterman<sup>3</sup> in an iterative algorithm between the INL lattice physics code and core simulator to iteratively update the Dancoff factor to treat this effect. This task shall either develop a similar algorithm and program between SCALE and PARCS (the equivalent of pebDAN in the EM for the PBR), or it shall implement another comparable methodology for calculating the Dancoff factor.
3. Spatial Heterogeneity Effects Boundary Treatment in PMRs. This task shall either develop a prismatic specific algorithm for treating the heterogeneity effects (the equivalent of prisDAN in the EM for the PMR), or it shall implement another comparable methodology for calculating the Dancoff factor.

Deliverables	Completion Date
Letter report documenting SQA for PARCS-SCALE coupling.	6 months after award
Source code for PBR and PMR algorithms for spatial heterogeneity boundary effects.	9 months after award

### Task 3. Improvements to the AGREE Code

The AGREE code was developed by Seker and Downar<sup>4</sup> to enable PARCS to perform steady state and transient coupled reactor kinetics/thermo-fluid analyses for the PBR design. It is a 3-D porous body gas dynamics and conduction code that employs essentially the same field equations and constitutive models as the THERMIX-DIREKT<sup>5</sup> code. Specific improvement tasks for the AGREE code are:

1. Numerical Scheme: Currently the three field equations (fluid flow, fluid energy, and structure energy) are solved individually and then iterated until a converged solution is

<sup>3</sup> Kloosterman, "Spatial Effects in DANCOFF Factor Calculations for Pebble Bed Reactors," ANS M&C Topical Meeting, Avignon, France, September, 2005.

<sup>4</sup> V. Seker and T. Downar, "Advanced Heat Transfer and Fluid Flow Calculations for Pebble Bed Reactors, International Conference on Emerging Nuclear Energy Systems (ICENES-2007), Istanbul, TURKEY, June 3-8, 2007.

<sup>5</sup> S. Struth, "DIREKT – A Computer Programme for Non-Steady, Two-Dimensional Simulation of Thermo-Hydraulic Transients," Kernforschungsanlage, Julich, JUL-1702, March 1999.

obtained. This procedure imposes significant time step limitations for some transients thereby greatly increasing the computational requirements for a coupled PARCS-AGREE calculation. The numerical scheme shall be updated to implement the simultaneous solution of the three field equations with a high degree of implicit coupling.

2. Kernel Temperature Calculation: Currently, the temperature inside a fuel pebble is calculated with a spherical one-dimensional conduction solution in a homogeneous medium. The Doppler feedback temperature is then calculated as the average value of the temperature inside the fuel matrix. This assumption is reasonable if the heat generation inside the fuel is slowly changing. However, for very rapid transients there will be a significant gradient between the fuel kernel and the graphite matrix. This task shall develop an analytic treatment for the kernel temperature and shall be coordinated with ongoing NRC supported heat transfer work at Nuclear Safety Solutions (Ltd.).
3. Extension to Prismatic Core: The flow solution shall be modified to include the 1-D axial momentum flux terms necessary for the calculation of PMRs. The capability to model cross-flows between fuel assemblies due to asymmetric graphite shrinkage shall also be included. Both the macro-scale heat conduction between fuel assemblies and the meso-scale heat conduction within a fuel assembly shall be modeled so that the temperatures of the graphite moderator, the coolant channel wall and the fuel can be calculated.

In the performance of this task, the contractor shall comply with code standards listed under Appendices A and B. Finally, the contractor shall also develop theory and user manuals for the AGREE code and keep these documents up to date to reflect the code changes resulting from the code improvement tasks described above.

Deliverables	Completion Date
Updated AGREE Source Code.	18 months after award
AGREE theory and user manuals.	24 months after award

#### Task 4. Development of an Equilibrium Cycle Algorithm

The PARCS and SCALE/TRITON codes currently have the depletion capability and the functionality to search for the equilibrium burnup core of an LWR. In this task, the contractor shall extend that ability to develop an equilibrium burnup capability for both the prismatic and the pebble bed VHTR designs.

A PBR operating at constant power for a sufficiently long time (on the order of 2 or 3 years) will approach asymptotic distributions of neutron flux and compositions. In principle, except to replace radiation-damaged reflector components, the PBR never needs to be shut down, so these asymptotic distributions will be approached more and more closely as time passes. To handle the complexities due to pebble flow and the stochastic nature of the recycle of burned and fresh pebbles, an algorithm similar to that of the INL's PEBBED code<sup>6</sup> or the V.S.O.P. code<sup>7</sup> shall be developed and incorporated into PARCS. This algorithm shall consider a vertical multi-

<sup>6</sup> W. K. Terry et al., "Direct Deterministic Method for Neutronics Analysis and Computation of Asymptotic Burnup Distribution in a Recirculating Pebble-Bed Reactor," *Annals of Nuclear Energy*, **29**, 1345-1364, 2002.

<sup>7</sup> Teuchert, E., Hansen, U., Haas, K. A., 1980. V.S.O.P. -- Computer Code System for Reactor Physics and Fuel Cycle Simulation. Kernforschungsanstalt Jülich, Jül-1649.

channel core representation and utilize pebble velocity and packing fraction distributions either specified by the user or values calculated using the INL PEBBLES<sup>8</sup> code. Pebbles would then be recycled in with a random distribution until convergence is achieved for the equilibrium cycle condition.

Prismatic-type reactors are batch-loaded, so the compositions change continuously with time. They do not approach asymptotic distributions as PBRs do, and operation is interrupted at intervals of roughly 2 years for fuel removal, shuffling, and replacement. However, after several operating cycles, the distribution of compositions at cycle startup approaches an asymptotic configuration. This task shall be to implement in PARCS an algorithm to shuffle fuel in order to obtain the equilibrium cycle for a PMR.

Deliverables	Completion Date
Letter report describing equilibrium cycle algorithm.	30 months after award
Updated PARCS Source Code.	36 months after award

#### Task 5. SNAP Based Driver for Core Analysis

The NRC's graphical user interface program, Symbolic Nuclear Analysis Package (SNAP), shall be used as the driver program for the steady-state core analysis component of the VHTR evaluation model. The contractor shall develop the necessary SNAP plug-ins to accomplish the coupling between the PARCS-AGREE and SCALE codes and their interface with the equilibrium cycle algorithm developed in Task No. 4. This task includes updating the PARCS plug-in for both PMR and PBR gas-cooled reactor designs and developing a plug-in for the AGREE code. The AGREE plug-in shall make maximum possible use of geometry information already input for PARCS to minimize redundant input requirements for the user. This task also includes reformatting the graphics information from AGREE into an NRC databank format that can be read by APTPlot and so used with AVScript.

Deliverables	Completion Date
SNAP plug-ins.	42 months after award
User's guide.	42 months after award

#### Task 6. PARCS-AGREE Infrastructure for Uncertainty Analysis

Where possible, the NRC evaluation model for VHTRs will utilize a best-estimate plus uncertainty approach. Uncertainties in the plant geometry and operating conditions can be directly addressed via perturbations of the plant input model. To also allow for the uncertainties associated with the constitutive models, correlations, nuclear data and algorithms used in the PARCS-AGREE code, the contractor shall develop a set of multipliers that can be used in

<sup>8</sup> J. J. Cogliati and A. M. Ougouag, "PEBBLES: A Computer Code for Modeling Packing, Flow and Recirculation of Pebbles in a Pebble Bed Reactor," *Proceedings HTR2006: 3<sup>rd</sup> International Topical Meeting on High Temperature Reactor Technology*, Johannesburg, South Africa, October 1-4, 2006.

uncertainty and sensitivity studies. These multipliers shall allow the user to directly bias a model in the PARCS-AGREE code through its specification in the input model. One example would be a multiplier upon the convective heat transfer coefficient between a pebble and the gas coolant in the core of a PBR that the user could vary over the uncertainty range on the correlation.

The contractor shall first develop a proposed list of the multipliers to be incorporated into PARCS-AGREE that shall be transmitted to the NRC as a letter report. Upon concurrence by the NRC project manager, the contractor shall then incorporate these into the source code.

Deliverables	Completion Date
Letter report with proposed list of multipliers.	30 months after award
Updated PARCS-AGREE source code.	36 months after award
Updated PARCS-AGREE user's manual.	36 months after award

#### **Task 7. PARCS-AGREE Coupling with MELCOR**

In previous work, the PARCS code has been coupled to the TRACE system analysis code to allow for coupled reactor kinetics/thermal-hydraulic calculations for light water reactors. For the NRC's VHTR evaluation model, the MELCOR code shall be used for the thermo-fluid analysis of the reactor system. Also, in a related project, the PARCS code shall be coupled with MELCOR

to provide this capability for gas reactors. However, for some postulated transients in VHTRs such as control rod ejection, a much finer resolution of the core thermal state is required than is practicable with MELCOR. To accommodate these transients, the contractor shall explicitly couple the AGREE code to MELCOR so that a detailed core analysis can be performed while the system state is calculated using MELCOR. Validation of the PARCS-AGREE coupling with MELCOR shall be performed by analyzing the steady state and transient cases of the OECD/NEA PBR-400 benchmark problem and the International Atomic Energy Agency HTRR and HTR-10 benchmarks.

Deliverables	Completion Date
Letter report describing the coupling and the benchmark results.	48 months after award
Updated PARCS-AGREE source code.	48 months after award

#### **Task 8. PARCS-AGREE Benchmarking and Assessment**

In consultation with the NRC, the contractor shall develop a plan for the benchmarking and assessment of the PARCS-AGREE code. In addition to benchmarking exercises such as the OECD/NEA PBR-400 and the IAEA HTR-10 mentioned above, comparisons to 3-D Monte Carlo calculations for nuclear reactors to validate PARCS for VHTR applications will be considered. To validate the gas dynamic and heat transfer models of the AGREE code, an

assessment matrix primarily composed of separate effect tests shall be included in the plan to be submitted to the NRC as a letter report.

Once the plan has been approved by the NRC project manager, the contractor shall perform the agreed upon code benchmarking and assessment tasks. The deliverables from this task include an assessment report, the code input models, and the AVScript files necessary to readily repeat the assessment calculations.

<b>Deliverables</b>	<b>Completion Date</b>
Letter report documenting benchmarking and assessment plan.	48 months after award
Letter report describing the benchmark and assessment results.	60 months after award
Input models and AVScripts necessary to repeat the calculations.	60 months after award

#### **Task 9. Analysis Support**

Continuing code analysis support and consultation is needed in various forms, potentially including but not limited to the provision of (a) on-the-job or formal code user training, (b) applied analysis assistance, (c) pre-analysis scoping studies, (d) experience-based technical insights and advice, (e) analysis knowledge management and preservation, (f) support for phenomena identification and ranking table (PIRT) processes, (g) analysis peer review, and (h) responses to questions and comments from code users. The contractor shall also work with the NRC project manager to coordinate research studies with closely related RES projects. This task provides 6 staff months of effort for the contractor to respond to NRC requests for analysis support.

<b>Deliverables</b>	<b>Completion Date</b>
Technical Analysis Support.	60 months after award

#### **V. RESEARCH QUALITY**

The quality of NRC research programs is assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

- Results meet the objectives (75 percent of overall score)
  - Justification of major assumptions (12 percent)
  - Soundness of technical approach and results (52 percent)
  - Uncertainties and sensitivities addressed (11 percent)
- Documentation of research results and methods is adequate (25 percent of overall score)
  - Clarity of presentation (16 percent)
  - Identification of major assumptions (9 percent)

It is the responsibility of the contractor to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC project manager and technical monitor will review all research products with these criteria in mind.

## VI. PUBLICATIONS NOTE

RES encourages the publication of the scientific results from RES sponsored programs in refereed scientific and engineering journals as appropriate. Additional information regarding the publication of NRC sponsored research is contained in NRC Management Directives 3.7, "NUREG Series Publications".

If the presentation or paper is in addition to the required technical reports and the RES Project Manager determines that it will benefit the RES project, the Project Manager may authorize payment of travel and publishing costs, if any, from the project funds. If the Project Manager determines that the article or presentation would not benefit the RES project, the costs associated with the preparation, presentation, or publication will be borne by the contractor. For any publication or presentations falling into this category, the NRC reserves the right to require that such presentation or publication will not identify the NRC's sponsorship of the work.

## VII. NEW STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS

The NRC began to capture most of its official records electronically on January 1, 2000. The NRC will capture each final NRC technical report designation (NUREG)-series publication in its native application. Therefore, please submit your final manuscript that has been approved by your NRC Project Manager in both electronic and camera-ready copy.

All format guidance, as specified in NUREG-0650 "Preparing for NUREG Series Publications," Revision 2, will remain the same with one exception. You will no longer be required to include the NUREG-series designator on the bottom of each page of the manuscript. The NRC will assign this designator when we send the camera-ready copy to the printer and will place the designator on the cover, title page, and spine. The designator for each report will no longer be assigned when the decision to prepare a publication is made. The NRC's Publishing Services Branch will inform the NRC Project Manager for the publication of the assigned designator when the final manuscript is sent to the printer.

For the electronic manuscript, the Contractor shall prepare the text in Microsoft Word, and use any of the following file types for charts, spreadsheets, and the like.

File Types to be Used for NUREG-Series Publications	
File Type	File Extension
Microsoft®Word®	.doc
Microsoft® PowerPoint®	.ppt
Microsoft®Excel	.xls
Microsoft®Access	.mdb
Portable Document Format	.pdf

This list is subject to change if new software packages come into common use at NRC or by our licensees or other stakeholders that participate in the electronic submission process. If a portion of your manuscript is from another source and you cannot obtain an acceptable electronic file type for this portion (e.g., an appendix from an old publication), the NRC can, if necessary, create a tagged image file format (file extension.tif) for that portion of your report. Note that you should continue to submit original photographs, which will be scanned, since digitized photographs do not print well.

If you choose to publish a compact disk (CD) of your publication, place on the CD copies of the manuscript in both (1) a portable document format (PDF); (2) a Microsoft Word file format, and (3) an Adobe Acrobat Reader, or, alternatively, print instructions for obtaining a free copy of Adobe Acrobat Reader on the back cover insert of the jewel box.

### **VIII. MEETINGS AND TRAVEL**

It is anticipated that contract reporting requirements will be satisfied with a total of five trips of 2-day duration for two persons. Meetings will be approved as needed for consultation with NRC staff or for presentation of the work to technical conferences or meetings. The contractor shall present the technical progress of the project at NRC headquarters on an annual basis, and make additional trips to NRC related contractor meetings and professional technical symposia as requested by the NRC project manager. Any additional domestic travel to be charged against project funds requires prior approval by the NRC project manager. All foreign travel related to and/or funded by the project must be approved in writing by the NRC project manager. For purposes of planning, the contractor shall estimate one annual visit to NRC Headquarters and two annual trips to technical workshops or professional meetings and a total of three international trips.

### **IX. CAPITAL EQUIPMENT**

All capital equipment expenditures, including the purchase of computer codes related and charged to this project, require the prior written approval of the NRC project officer.

### **X. DISPOSAL OF PROPERTIES**

The contractor shall discuss and with the approval of the NRC determine the ultimate disposition of equipment and instrumentation purchased and developed during the course of the contract. A letter from the contractor shall itemize and discuss the contractor's plans for transfer, retention and disposal of all equipment, information, software and technical reports.

## Appendix A

## Special Requirements

All code development activities must follow principles described in NUREG-1737 "Software Quality Assurance Procedures for NRC Thermal Hydraulic Codes," and adhere to the Programming Guidelines and Design Philosophies as outlined on the TRACE Development website <https://trace.nrc.gov>. The contractor shall prepare a Software Requirements Document (SRD) (using an established NRC Framemaker template), Test Plan, and Software Design and Implementation Document (SDID) before implementing new models or features and submit them to NRC for their approval. Upon approval of the SRD and SDID, the contractor shall implement the changes. The results of the programming effort shall be documented in a Completion Report. The contractor does have the freedom to combine these documents, where appropriate and with NRC approval. It is important that the relevant topics belonging to each document be addressed and formally communicated.

All code transmittal packages shall be generated using the buildTransmittal.pl perl script and shall include the following:

- SQA documentation
- Patch files to the TRACE source in diff format
- Modified source files
- HTML summary file explaining the nature of the changes and testing
- Modified test input files (if any)
- Newly added test input decks (if any)
- HTML results of the testSummary.pl script (generated for the regression test set)
- AVScript input files (if applicable)
- Scripts or programming tools that might have been used/generated in the course of completing the update

If changes to the code manuals are required in conjunction with a particular update, the contractor may be asked by NRC to make those modifications in addition to the SQA documentation outlined above. Regarding this issue, it is NRC's expectation that the contractor shall become familiar with the content of each chapter in each manual so that manual changes are applied comprehensively and at a level of detail similar to the content that surrounds the modified or added text. The contractor shall ensure that inconsistencies between various sections of content (either in thought or in nomenclature) are not introduced.

Changes to manuals shall generally be made to the on-line, official electronic files directly. In cases where this practice is either not prudent or not possible, the contractor shall use Framemaker's built-in change bar feature to call out modifications to make it easier for NRC staff to integrate those changes into the official electronic files at the appropriate time.

The NRC will not consider it acceptable to submit graduate theses as the final product of research. All final assessment reports shall use NRC-supplied Framemaker templates and in accordance with the specifications provided in the Statement of Work.

The development of all assessment input problems shall be accompanied by the development of a calculation notebook that justifies the use of every value provided in the model. For every value, the calculation notebook shall answer the questions such as

- What is it?
- Why was it chosen?
- What did you have to assume?
- How was it calculated? and/or
- Where did it come from?

The calculation notebook shall be prepared in an electronic format using a template to be provided by the NRC.

**TRACE Standard F90  
Programming Practices and  
General Design Philosophies**

Last updated: 12/07/2005

Developers shall adhere to these practices for all new coding. Please send feedback to [Christopher.Murray@nrc.gov](mailto:Christopher.Murray@nrc.gov). Improper style in old coding will be corrected as resources permit.

\* Write GOOD requirements - see

<http://www.incose.org/workgrps/rwg/writing.html>. for some online guidelines.

\* All code software quality assurance reports and code documentation shall be prepared and submitted to NRC in Framemaker format. Equations shall be generated using Framemaker's built-in equation tools. Line and vector-based diagrams shall be generated using Framemaker's built-in drawing tools. In cases where this is not possible, the original picture files shall accompany the document and be in a format editable by common drawing tools (eps, svg, mif, pdf, cdr). Use encapsulated postscript (eps) only as a very last resort - we expect developers to employ modern drawing tools that will not lead to this limitation. For engineering plots, ACGrace is the preferred program for generating such plots. Save them to mif format for importing into a Framemaker document. Plots shall NOT be imported as bitmap images (use vector formats instead. For raster/bitmap pictures, the image may be inserted directly into the document, but the transmittal shall include the image in its own file in a standard format (gif, png, or jpg).

\* All new variables will be explicitly typed, and all new routines shall include IMPLICIT NONE statements.

\* Implement a standard KIND representation for Integers and Reals

+ Always insert the line "USE IntrType" after the MODULE statement, or for any subprograms that are not module procedures, after the SUBROUTINE or FUNCTION statement. If IntrType is declared at the module level, there is no need to include it within the CONTAINED subroutines.

+ Begin all definitions of real variables with "REAL(sdk)"

+ Begin all definitions of integer variables with "INTEGER(sik)"

\* All use of real and integer constants should be implemented with the \_sdk and \_sik kind type parameters.

+ For example, use 2\_sik instead of just 2, or 1.0e+10\_sdk instead of 1.0d+10, etc

\* Do not use continuation lines inside of variable declaration statements.

\* When declaring a variable of TYPE POINTER, ALWAYS initialize it with the => NULL() syntax.

\* Get in the habit of using default initialization whenever variables are declared, but keep in mind that use of this syntax implies the SAVE attribute for any variable for which this is done.

Developers should get in the habit of using the ONLY syntax in their USE statements. This prevents unintended variables from coming into scope and preventing the compiler from detecting instances where a local variable is undeclared or an unintended global variable is used mistakenly (as can happen with variables like cco when cutting and pasting code).

\* Developers should always strive for object-oriented designs. What does this imply? It means that coding should be data-centric. In other words, design the data structure first. Make it flexible enough to handle all possible situations for which you could ever envision needing it. Once an effective data structure is fleshed out, on paper, begin to think about methods that operate on that data structure. As a minimum, there ought to be constructor/initialization and destructor methods for the data structure as a whole and any substructure pointer or allocatable arrays that might exist. Make the data structure PRIVATE to the module of interest. Access to the data structure shall only be through subroutines or functions. Factor these ideas into your proposals and predictions about time and cost. NRC will expect it. The penalty with these sorts of designs is in run-time speed, so there may be situations where such designs don't make sense but a developer's priorities should be object-oriented first, run-time second. Speed can always be recaptured in the next generation of processors or by optimizing other aspects of the code. If resource permit, some prototyping of various methodologies to understand the exact costs/benefits would be appropriate.

\* All dummy arguments and important local variables should be declared within their own TYPE declaration declaration statements.

\* The INTENT of all dummy arguments should be declared in all new coding.

\* Do not use bare END statements.

\* All Fortran statements, attributes, intrinsic subprograms, and logical operators in new coding shall be in all upper case.

```
REAL(sdk), POINTER, DIMENSION(:, :) :: a, aa
```

```
IF ( i.GT.j ) THEN
```

\* Leading and trailing underscores shall not be used in any names (due to the potential for name mangling issues during linking), but underscores in the middle of names are allowed.

\* Variable, file, and procedure names will be long enough to be self-documenting, within reason, with a suggested limit of 15-20 characters.

\* All new variable names shall have the first letter of each sub-element capitalized except the first, as in pipeData.

\* All derived type names shall end in "T", as in pipeDataT.

\* Module and subprogram names will begin with a capitalized letter, but don't change old subprogram names.

\* All new coding shall be structured, with an indentation level of three spaces.

```
DO i = 1,n
  DO j = 1,n
    IF (i.gt.j) THEN
      a(i,j) = - aa(j,i)
    ELSE
      a(i,j) = aa(i,j)
    ENDIF
  ENDIF
ENDIF
```

ENDDO

ENDDO

- \* Use IF-THEN-ENDIF instead of IF (condition) statement.
- \* "GOTO" statements shall be used sparingly, if at all. Instead, programmers should use IF-THEN-ELSE, SELECT CASE, CYCLE, EXIT, and internal subprograms as appropriate.
- \* Use standard F90 free format code style with the following exceptions:
  - + a limit of 110 columns per line
  - + Source code should generally start in column 7. Columns 1-6 are to be reserved for statement labels. This does not apply to comments and MODULE statements.
- \* Comments lines are indicated with a "!" in column 1.
- \* Comments that serve to delineate, summarize, and/or clarify larger multi-step algorithms shall be indented one or two spaces.
- \* Comments that serve to clarify the intent of and/or summarize small blocks of code shall be given the same indentation level as that code.
- \* Comments shall be offset by at least one blank line from the previous F90 statement.
- \* Never place a comment at the end of a continued line (illegal Fortran).

Try not to ever use multi-line statements. It makes writing scripts to parse FORTRAN more difficult and invalidates line coverage profiling studies.

\* End-of-line comments should not be used except in context of data type declaration statements or where a brief comment on the same line as the statement clearly accentuates and improves the readability and intent of the IF statement or block that follows, ala

```
INTEGER(sik) :: height = 0.0_sdk ! height of the cell.
```

or

```
IF (fillTab(cco)%flowin .GE. 0.0d0) THEN !Determine donor cell mixture.
```

- \* Comment blocks should generally not be longer than a dozen lines (additional information can go in the programmer's manual, and/or the SDID subroutine report).
- \* Authorship information shall be included for each new subroutine that a developer creates or rewrites from scratch. When significant, well defined blocks of changes (on the order of 100 lines or more) are made to an existing subroutine, a note should be placed directly beneath the existing authorship info (or below the subroutine purpose if it doesn't) denoting the name, organization, date and quick description of the modifications. Authorship info should not be provided when the changes are spread out (i.e. not in well defined blocks) - even if they significantly modify some behavior of the algorithm contained therein - although the subroutine description should be checked for accuracy and modified when appropriate.
- \* The following standard template should be used for each new subroutine that is developed (a plug-in to Visual Fortran has been created which can create this automatically):

```

SUBROUTINE SampleSub()
!
USE IntrType
IMPLICIT NONE
!
! The purpose of this routine is to <<Insert Description here>>
!
! Programmed by Name, Organization, Date (Month/Year)
!
! Subroutine Argument Descriptions:

! Variable Declarations:

RETURN.
!
END SUBROUTINE SampleSub.
!

```

When making a change, in general do not comment out the old coding but instead delete it.

- \* Do not surround your coding with your initials - it just uglifies the code.
- \* Never use COMMON. Use a MODULE and corresponding USE instead.
- \* Never use EQUIVALENCE. Use POINTERS if you must, but better practice is to redesign so pointers are not necessary.
- \* All code shall be standard F90 - no use of non-standard compiler extensions or preprocessor definitions are allowed.
- \* If available in the compiler, all code should be developed with strict F90 standards checking and array bounds checking turned on. Also, compiler flags should be engaged which check for any unused variables and uninitialized variables. If any unused variables are located in a routine that a developer touches, then he or she shall remove them.
- \* If a new subroutine is added to the code outside the scope of a MODULE statement, then an explicit interface to that routine should be created. This allows the compiler to handle checking of the argument lists at compile time.
- \* Developers shall remove any unused subroutines which are created as a result of their efforts.
- \* When incorporating legacy code from other computer codes into TRACE, every effort should be made to clean that code up and make sure it conforms to the stylistic rules and design philosophies outlined in this document.

When preparing an SRD for a particular development project, the requirements should take into account the planned update's effect on or interaction with such areas as:

- + restart processing
- + CSS controllers
- + control system

+ exterior component and other parallel programming interfaces

+ timestep backup flow logic

+ SNAP and/or VEDA

+ English units

\* Any modification or enhancement of inter-component transfer of information should never involve direct modification of bd array elements. All transfer should be arranged during the initialization phase of the calculation (module SysService) through the system service transfer tables.

## **SECTION D - PACKAGING AND MARKING**

### **D.1 PACKAGING AND MARKING (MAR 1987)**

The Contractor shall package material for shipment to the NRC in such a manner that will ensure acceptance by common carrier and safe delivery at destination. Containers and closures shall comply with the Interstate Commerce Commission Regulations, Uniform Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation. On the front of the package, the Contractor shall clearly identify the contract number under which the product is being provided.

**SECTION E - INSPECTION AND ACCEPTANCE****E.1 NOTICE LISTING CONTRACT CLAUSES INCORPORATED BY REFERENCE**

The following contract clauses pertinent to this section are hereby incorporated by reference (by Citation Number, Title, and Date) in accordance with the clause at FAR "52.252-2 CLAUSES INCORPORATED BY REFERENCE" in Section I of this contract. See FAR 52.252-2 for an internet address (if specified) for electronic access to the full-text of a clause.

NUMBER	TITLE	DATE
52.246-9	FEDERAL ACQUISITION REGULATION (48 CFR Chapter 1) INSPECTION OF RESEARCH AND DEVELOPMENT (SHORT FORM)	APR 1984

**E.2. PLACE OF INSPECTION AND ACCEPTANCE (MAR 1987)**

Inspection and acceptance of the deliverable items to be furnished hereunder shall be made by the Project Officer at the destination.

**SECTION F - DELIVERIES OR PERFORMANCE****F.1 NOTICE LISTING CONTRACT CLAUSES INCORPORATED BY REFERENCE**

The following contract clauses pertinent to this section are hereby incorporated by reference (by Citation Number, Title, and Date) in accordance with the clause at FAR "52.252-2 CLAUSES INCORPORATED BY REFERENCE" in Section I of this contract. See FAR 52.252-2 for an internet address (if specified) for electronic access to the full text of a clause.

NUMBER	TITLE	DATE
52.242-15	FEDERAL ACQUISITION REGULATION (48 CFR Chapter 1) STOP-WORK ORDER ALTERNATE I (APR 1984)	AUG 1989
52.247-34	F.O.B. DESTINATION	NOV 1991

**F.2 2052.211-70 PREPARATION OF TECHNICAL REPORTS (JAN 1993)**

All technical reports required by Section C and all Technical Progress Reports required by Section F are to be prepared in accordance with Management Directive 3.7, "NUREG-Series Publications" available at <http://www.nrc.gov/reading-rm/doc-collections/management-directives/volumes/vol-3.html>. Management Directive 3.7 is not applicable to any Contractor Spending Plan (CSP) and any Financial Status Report that may be included in this contract.

**F.3 2052.211-71 TECHNICAL PROGRESS REPORT (JAN 1993)**

The contractor shall provide a monthly Technical Progress Report to the project officer and the contracting officer. The report is due within 15 calendar days after the end of the report period and must identify the title of the project, the contract number, appropriate financial tracking code specified by the NRC Project Officer, project manager and/or principal investigator, the contract period of performance, and the period covered by the report. Each report must include the following for each discrete task/task order:

- (a) A listing of the efforts completed during the period, and milestones reached or, if missed, an explanation provided;
- (b) Any problems or delays encountered or anticipated and recommendations for resolution. If the recommended resolution involves a contract modification, e.g., change in work requirements, level of effort (cost) or schedule delay, the contractor shall submit a separate letter to the contracting officer identifying the required change and estimated cost impact.
- (c) A summary of progress to date; and
- (d) Plans for the next reporting period.

**F.4 2052.211-72 FINANCIAL STATUS REPORT (OCT 1999)**

The contractor shall provide a monthly Financial Status Report (FSR) to the project officer and the contracting officer. The FSR shall include the acquisition of, or changes in the status of, contractor-held property acquired with government funds valued at the time of purchase at \$50,000 or more. Whenever these types of property changes occur, the contractor shall send a copy of the report to the Chief, Property and Acquisition Oversight Branch, Office of Administration. The report is due within 15 calendar days after the end of the report period and must identify the title of the project, the contract number, the appropriate financial

tracking code (e.g., Job Code Number or JCN) specified by the NRC Project Officer, project manager and/or principal investigator, the contract period of performance, and the period covered by the report. Each report must include the following for each discrete task:

- (a) Total estimated contract amount.
- (b) Total funds obligated to date.
- (c) Total costs incurred this reporting period.
- (d) Total costs incurred to date.
- (e) Detail of all direct and indirect costs incurred during the reporting period for the entire contract or each task, if it is a task ordering contract.
- (f) Balance of obligations remaining.
- (g) Balance of funds required to complete contract/task order.
- (h) Contractor Spending Plan (CSP) status: A revised CSP is required with the Financial Status Report whenever the contractor or the contracting officer has reason to believe that the total cost for performance of this contract will be either greater or substantially less than what had been previously estimated.
  - (1) Projected percentage of completion cumulative through the report period for the project/task order as reflected in the current CSP.
  - (2) Indicate significant changes in the original CSP projection in either dollars or percentage of completion. Identify the change, the reasons for the change, whether there is any projected overrun, and when additional funds would be required. If there have been no changes to the original NRC-approved CSP projections, a written statement to that effect is sufficient in lieu of submitting a detailed response to item "h".
- (i) Property status:
  - (1) List property acquired for the project during the month with an acquisition cost between \$500 and \$49,999. Give the item number for the specific piece of equipment.
  - (2) Provide a separate list of property acquired for the project during the month with an acquisition cost of \$50,000 or more. Provide the following information for each item of property: item description or nomenclature, manufacturer, model number, serial number, acquisition cost, and receipt date. If no property was acquired during the month, include a statement to that effect. The same information must be provided for any component or peripheral equipment which is part of a "system or system unit."
  - (3) For multi-year projects, in the September monthly financial status report provide a cumulative listing of property with an acquisition cost of \$50,000 or more showing the information specified in paragraph (i)(2) of this clause.
  - (4) In the final financial status report provide a closeout property report containing the same elements as described above for the monthly financial status reports, for all property purchased with NRC funds regardless of value unless title has been vested in the contractor. If no property was acquired under the contract, provide a statement to that effect. The report should note any property requiring special handling for security, health, safety, or other reasons as part of the report.
- (j) Travel status: List the starting and ending dates for each trip, the starting point and destination, and the traveler(s) for each trip.

(k) If the data in this report indicates a need for additional funding beyond that already obligated, this information may only be used as support to the official request for funding required in accordance with the Limitation of Cost (LOC) Clause (FAR 52.232-20) or the Limitation of Funds (LOF) Clause FAR 52.232-22.

### **F.5 DELIVERY SCHEDULE**

The contractor shall deliver the deliverables specified in the statement of work. In addition, the contractor shall also provide a monthly technical progress report and a financial status report (as described in sections F.3 and F.4 of the terms and conditions): These reports are due the 20<sup>th</sup> of each month.

### **F.6 PLACE OF DELIVERY--REPORTS (JUN 1988)**

The items to be furnished hereunder shall be delivered, with all charges paid by the Contractor, to:

- a) Project Officer (1 hard copy and one electronic copy)
- b) Technical monitor (1 copy)
- c) Contracting Officer (1 hard copy) deliver to:

US Nuclear Regulatory Commission  
Attn: Contract NRC-04-09-125  
Mail Stop: TWB-01-B10M  
Washington DC 20555

- d) One copy should be sent to: [RESDSAMLSR.resource@nrc.gov](mailto:RESDSAMLSR.resource@nrc.gov)
- e) One copy should be sent to: [RESPMDAMLSR@nrc.gov](mailto:RESPMDAMLSR@nrc.gov)

### **F.7 DURATION OF CONTRACT PERIOD (MAR 1987)**

This contract shall commence on award date and expire five years after award.

**SECTION G - CONTRACT ADMINISTRATION DATA****G.1 2052.215-71 PROJECT OFFICER AUTHORITY (NOVEMBER 2006)**

(a) The contracting officer's authorized representative (hereinafter referred to as the project officer) for this contract is:

Name: Nathanael Hudson

Address: U.S. Nuclear Regulatory Commission  
Office of Nuclear Regulatory Research  
Mail Stop: C3A07M  
Washington DC 20555

Telephone Number: 301-251-7534

Email: [nathanael.hudson@nrc.gov](mailto:nathanael.hudson@nrc.gov)

(b) Performance of the work under this contract is subject to the technical direction of the NRC project officer. The term "technical direction" is defined to include the following:

(1) Technical direction to the contractor which shifts work emphasis between areas of work or tasks, authorizes travel which was unanticipated in the Schedule (i.e., travel not contemplated in the Statement of Work (SOW) or changes to specific travel identified in the SOW), fills in details, or otherwise serves to accomplish the contractual SOW.

(2) Provide advice and guidance to the contractor in the preparation of drawings, specifications, or technical portions of the work description.

(3) Review and, where required by the contract, approval of technical reports, drawings, specifications, and technical information to be delivered by the contractor to the Government under the contract.

(c) Technical direction must be within the general statement of work stated in the contract. The project officer does not have the authority to and may not issue any technical direction which:

(1) Constitutes an assignment of work outside the general scope of the contract.

(2) Constitutes a change as defined in the "Changes" clause of this contract.

(3) In any way causes an increase or decrease in the total estimated contract cost, the fixed fee, if any, or the time required for contract performance.

(4) Changes any of the expressed terms, conditions, or specifications of the contract.

(5) Terminates the contract, settles any claim or dispute arising under the contract, or issues any unilateral directive whatever.

(d) All technical directions must be issued in writing by the project officer or must be confirmed by the project officer in writing within ten (10) working days after verbal issuance. A copy of the written direction must be furnished to the contracting officer. A copy of NRC Form 445, Request for Approval of Official Foreign Travel, which has received final approval from the NRC must be furnished to the contracting officer.

(e) The contractor shall proceed promptly with the performance of technical directions duly issued by the project officer in the manner prescribed by this clause and within the project officer's authority under the provisions of this clause.

(f) If, in the opinion of the contractor, any instruction or direction issued by the project officer is within one of the categories as defined in paragraph (c) of this section, the contractor may not proceed but shall notify the contracting officer in writing within five (5) working days after the receipt of any instruction or direction and shall request the contracting officer to modify the contract accordingly. Upon receiving the notification from the contractor, the contracting officer shall issue an appropriate contract modification or advise the contractor in writing that, in the contracting officer's opinion, the technical direction is within the scope of this article and does not constitute a change under the "Changes" clause.

(g) Any unauthorized commitment or direction issued by the project officer may result in an unnecessary delay in the contractor's performance and may even result in the contractor expending funds for unallowable costs under the contract.

(h) A failure of the parties to agree upon the nature of the instruction or direction or upon the contract action to be taken with respect thereto is subject to 52.233-1 -Disputes.

(i) In addition to providing technical direction as defined in paragraph (b) of the section, the project officer shall:

(1) Monitor the contractor's technical progress, including surveillance and assessment of performance, and recommend to the contracting officer changes in requirements.

(2) Assist the contractor in the resolution of technical problems encountered during performance.

(3) Review all costs requested for reimbursement by the contractor and submit to the contracting officer recommendations for approval, disapproval, or suspension of payment for supplies and services required under this contract.

(4) Assist the contractor in obtaining the badges for the contractor personnel.

(5) Immediately notify the Security Branch, Division of Facilities and Security (SB/DFS) (via e-mail) when a contractor employee no longer requires access authorization and return of any NRC issued badge to SB/DFS within three days after their termination.

(6) Ensure that all contractor employees that require access to classified Restricted Data or National Security Information or matter, access to sensitive unclassified information (Safeguards, Official Use Only, and Proprietary information) access to sensitive IT systems or data, unescorted access to NRC controlled buildings/space, or unescorted access to protected and vital areas of nuclear power plants receive approval of SB/DFS prior to access in accordance with Management Directive and Handbook 12.3.

(7) For contracts for the design, development, maintenance or operation of Privacy Act Systems of Records, obtain from the contractor as part of closeout procedures, written certification that the contractor has returned to NRC, transferred to the successor contractor, or destroyed at the end of the contract in accordance with instructions provided by the NRC Systems Manager for Privacy Act Systems of Records, all records (electronic or paper) which were created, compiled, obtained or maintained under the contract.

**G.2 2052.215-77 TRAVEL APPROVALS AND REIMBURSEMENT (OCT 1999)**

(a) All foreign travel must be approved in advance by the NRC on NRC Form 445, Request for Approval of Official Foreign Travel, and must be in compliance with FAR 52.247-63 Preference for U.S. Flag Air Carriers. The contractor shall submit NRC Form 445 to the NRC no later than 30 days before beginning travel.

(b) The contractor must receive written approval from the NRC Project Officer before taking travel that was unanticipated in the Schedule (i.e., travel not contemplated in the Statement of Work, or changes to specific travel identified in the Statement of Work).

(c) The contractor will be reimbursed only for those travel costs incurred that are directly related to this contract and are allowable subject to the limitations prescribed in FAR 31.205-46.

(d) It is the responsibility of the contractor to notify the contracting officer in accordance with the Limitations of Cost clause of this contract when, at any time, the contractor learns that travel expenses will cause the contractor to exceed the estimated costs specified in the Schedule.

(e) Reasonable travel costs for research and related activities performed at State and nonprofit institutions, in accordance with Section 12 of Pub. L. 100-679, shall be charged in accordance with the contractor's institutional policy to the degree that the limitations of Office of Management and Budget (OMB) guidance are not exceeded. Applicable guidance documents include OMB Circular A-87, Cost Principles for State and Local Governments; OMB Circular A-122, Cost Principles for Nonprofit Organizations; and OMB Circular A-21, Cost Principles for Educational Institutions.

**G.3 2052.216-71 INDIRECT COST RATES-ALTERNATE 2 (OCT 1999)**

(a) For this contract, the ceiling amount reimbursable for indirect costs is as follows:

INDIRECT COST POOL	RATE	BASE	PERIOD
Indirect cost	[REDACTED]	MTDC	9/1/2009-until revised
Fringe – faculty	[REDACTED]	Direct labor	9/1/2009-until revised
Fringe – faculty	[REDACTED]	Direct labor	9/1/2009-until revised
Fringe – grad students	[REDACTED]	Direct labor	9/1/2009-until revised

(b) In the event that indirect rates developed by the cognizant audit activity on the basis of actual allowable costs result in a lower amount for indirect costs, the lower amount will be paid. The Government may not be obligated to pay any additional amounts for indirect costs above the ceiling rates set forth above for the applicable period.

**SECTION H - SPECIAL CONTRACT REQUIREMENTS****H.1 2052.209-72 CONTRACTOR ORGANIZATIONAL CONFLICTS OF INTEREST (JAN 1993)**

(a) Purpose. The primary purpose of this clause is to aid in ensuring that the contractor:

(1) Is not placed in a conflicting role because of current or planned interests (financial, contractual, organizational, or otherwise) which relate to the work under this contract; and

(2) Does not obtain an unfair competitive advantage over other parties by virtue of its performance of this contract.

(b) Scope. The restrictions described apply to performance or participation by the contractor, as defined in 48 CFR 2009.570-2 in the activities covered by this clause.

(c) Work for others.

(1) Notwithstanding any other provision of this contract, during the term of this contract, the contractor agrees to forego entering into consulting or other contractual arrangements with any firm or organization the result of which may give rise to a conflict of interest with respect to the work being performed under this contract. The contractor shall ensure that all employees under this contract abide by the provision of this clause. If the contractor has reason to believe, with respect to itself or any employee, that any proposed consultant or other contractual arrangement with any firm or organization may involve a potential conflict of interest, the contractor shall obtain the written approval of the contracting officer before the execution of such contractual arrangement.

(2) The contractor may not represent, assist, or otherwise support an NRC licensee or applicant undergoing an NRC audit, inspection, or review where the activities that are the subject of the audit, inspection, or review are the same as or substantially similar to the services within the scope of this contract (or task order as appropriate) except where the NRC licensee or applicant requires the contractor's support to explain or defend the contractor's prior work for the utility or other entity which NRC questions.

(3) When the contractor performs work for the NRC under this contract at any NRC licensee or applicant site, the contractor shall neither solicit nor perform work in the same or similar technical area for that licensee or applicant organization for a period commencing with the award of the task order or beginning of work on the site (if not a task order contract) and ending one year after completion of all work under the associated task order, or last time at the site (if not a task order contract).

(4) When the contractor performs work for the NRC under this contract at any NRC licensee or applicant site,

(i) The contractor may not solicit work at that site for that licensee or applicant during the period of performance of the task order or the contract, as appropriate.

(ii) The contractor may not perform work at that site for that licensee or applicant during the period of performance of the task order or the contract, as appropriate, and for one year thereafter.

(iii) Notwithstanding the foregoing, the contracting officer may authorize the contractor to solicit or perform this type of work (except work in the same or similar technical area) if the contracting officer determines that the situation will not pose a potential for technical bias or unfair competitive advantage.

(d) Disclosure after award.

(1) The contractor warrants that to the best of its knowledge and belief, and except as otherwise set forth in this contract, that it does not have any organizational conflicts of interest as defined in 48 CFR 2009.570-2.

(2) The contractor agrees that if, after award, it discovers organizational conflicts of interest with respect to this contract, it shall make an immediate and full disclosure in writing to the contracting officer. This statement must include a description of the action which the contractor has taken or proposes to take to avoid or mitigate such conflicts. The NRC may, however, terminate the contract if termination is in the best interest of the Government.

(3) It is recognized that the scope of work of a task-order-type contract necessarily encompasses a broad spectrum of activities. Consequently, if this is a task-order-type contract, the contractor agrees that it will disclose all proposed new work involving NRC licensees or applicants which comes within the scope of work of the underlying contract. Further, if this contract involves work at a licensee or applicant site, the contractor agrees to exercise diligence to discover and disclose any new work at that licensee or applicant site. This disclosure must be made before the submission of a bid or proposal to the utility or other regulated entity and must be received by the NRC at least 15 days before the proposed award date in any event, unless a written justification demonstrating urgency and due diligence to discover and disclose is provided by the contractor and approved by the contracting officer. The disclosure must include the statement of work, the dollar value of the proposed contract, and any other documents that are needed to fully describe the proposed work for the regulated utility or other regulated entity. NRC may deny approval of the disclosed work only when the NRC has issued a task order which includes the technical area and, if site-specific, the site, or has plans to issue a task order which includes the technical area and, if site-specific, the site, or when the work violates paragraphs (c)(2), (c)(3) or (c)(4) of this section.

(e) Access to and use of information.

(1) If in the performance of this contract, the contractor obtains access to information, such as NRC plans, policies, reports, studies, financial plans, internal data protected by the Privacy Act of 1974 (5 U.S.C. Section 552a (1988)), or the Freedom of Information Act (5 U.S.C. Section 552 (1986)), the contractor agrees not to:

(i) Use this information for any private purpose until the information has been released to the public;

(ii) Compete for work for the Commission based on the information for a period of six months after either the completion of this contract or the release of the information to the public, whichever is first;

(iii) Submit an unsolicited proposal to the Government based on the information until one year after the release of the information to the public; or

(iv) Release the information without prior written approval by the contracting officer unless the information has previously been released to the public by the NRC.

(2) In addition, the contractor agrees that, to the extent it receives or is given access to proprietary data, data protected by the Privacy Act of 1974 (5 U.S.C. Section 552a (1988)), or the Freedom of Information Act (5 U.S.C. Section 552 (1986)), or other confidential or privileged technical, business, or financial information under this contract, the contractor shall treat the information in accordance with restrictions placed on use of the information.

(3) Subject to patent and security provisions of this contract, the contractor shall have the right to use technical data it produces under this contract for private purposes provided that all requirements of this contract have been met.

(f) Subcontracts. Except as provided in 48 CFR 2009.570-2, the contractor shall include this clause, including this paragraph, in subcontracts of any tier. The terms contract, contractor, and contracting officer, must be appropriately modified to preserve the Government's rights.

(g) Remedies. For breach of any of the above restrictions, or for intentional nondisclosure or misrepresentation of any relevant interest required to be disclosed concerning this contract or for such erroneous representations that necessarily imply bad faith, the Government may terminate the contract for default, disqualify the contractor from subsequent contractual efforts, and pursue other remedies permitted by law or this contract.

(h) Waiver. A request for waiver under this clause must be directed in writing to the contracting officer in accordance with the procedures outlined in 48 CFR 2009.570-9.

(i) Follow-on effort. The contractor shall be ineligible to participate in NRC contracts, subcontracts, or proposals therefore (solicited or unsolicited), which stem directly from the contractor's performance of work under this contract. Furthermore, unless so directed in writing by the contracting officer, the contractor may not perform any technical consulting or management support services work or evaluation activities under this contract on any of its products or services or the products or services of another firm if the contractor has been substantially involved in the development or marketing of the products or services.

(1) If the contractor, under this contract, prepares a complete or essentially complete statement of work or specifications, the contractor is not eligible to perform or participate in the initial contractual effort which is based on the statement of work or specifications. The contractor may not incorporate its products or services in the statement of work or specifications unless so directed in writing by the contracting officer, in which case the restrictions in this paragraph do not apply.

(2) Nothing in this paragraph precludes the contractor from offering or selling its standard commercial items to the Government.

**H.2 2052.215-70 KEY PERSONNEL (JAN 1993)**

(a) The following individuals are considered to be essential to the successful performance of the work hereunder:



The contractor agrees that personnel may not be removed from the contract work or replaced without compliance with paragraphs (b) and (c) of this section.

(b) If one or more of the key personnel, for whatever reason, becomes, or is expected to become, unavailable for work under this contract for a continuous period exceeding 30 work days, or is expected to devote substantially less effort to the work than indicated in the proposal or initially anticipated, the contractor shall immediately notify the contracting officer and shall, subject to the concurrence of the contracting officer, promptly replace the personnel with personnel of at least substantially equal ability and qualifications.

(c) Each request for approval of substitutions must be in writing and contain a detailed explanation of the circumstances necessitating the proposed substitutions. The request must also contain a complete resume for the proposed substitute and other information requested or needed by the contracting officer to evaluate the proposed substitution. The contracting officer and the project officer shall evaluate the contractor's request and the contracting officer shall promptly notify the contractor of his or her decision in writing.

(d) If the contracting officer determines that suitable and timely replacement of key personnel who have been reassigned, terminated, or have otherwise become unavailable for the contract work is not reasonably forthcoming, or that the resultant reduction of productive effort would be so substantial as to impair the successful completion of the contract or the service order, the contract may be terminated by the contracting officer for default or for the convenience of the Government, as appropriate. If the contracting officer finds the contractor at fault for the condition, the contract price or fixed fee may be equitably adjusted downward to compensate the Government for any resultant delay, loss, or damage.

### **H.3 MODIFICATION TO 2052.235-70 PUBLICATION OF RESEARCH RESULTS (OCT 1999)**

(a) The principal investigator(s)/contractor shall comply with the provisions of NRC Management Directive 3.8 (Vol. 3, Part 1) and NRC Handbook 3.8 (Parts I-IV) regarding publication in refereed scientific and engineering journals or dissemination to the public of any information, oral or written, concerning the work performed under this contract. This unclassified fundamental research project requires the development of research methodologies. The scope of work of this project does not involve making conclusions or recommendations regarding NRC policy.

(b) The principal investigator(s)/contractor may publish the results of this work in refereed scientific and engineering journals or in open literature and present papers at public or association meetings at interim stages of work, in addition to submitting to NRC the final reports and other deliverables required under this contract.

(c) The principal investigator(s) shall coordinate all such publications with, and transmit a copy of the proposed article or paper to, the NRC Contracting Officer or Project Officer, prior to publication. The NRC agrees to review and provide comments within thirty (30) days after receipt of a proposed publication. However, in those cases where the information to be published addresses and/or discusses NRC policy, the NRC reserves the right to have the contractor add the following disclaimer that states "Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the NRC".

### **H.4 2052.235-71 SAFETY, HEALTH, AND FIRE PROTECTION (JAN 1993)**

The contractor shall take all reasonable precautions in the performance of the work under this contract to protect the health and safety of its employees and of members of the public, including NRC employees and contractor personnel, and to minimize danger from all hazards to life and property. The contractor shall comply with all applicable health, safety, and fire protection regulations and requirements (including reporting requirements) of the Commission and the Department of Labor. If the contractor fails to comply with these regulations or requirements, the contracting office may, without prejudice to any other legal or contractual rights of the Commission, issue an order stopping all or any part of the work. Thereafter, a start work order for resumption of work may be issued at the discretion of the contracting officer. The contractor may not make a claim for an extension of time or for compensation or damages by reason of, or in connection with, this type of work stoppage.

### **H.5 GOVERNMENT FURNISHED EQUIPMENT/PROPERTY - NONE PROVIDED (JUN 1988)**

The Government will not provide any equipment/property under this contract.

### **H.6 SEAT BELTS**

Contractors, subcontractors, and grantees, are encouraged to adopt and enforce on-the-job seat belt policies and programs for their employees when operating company-owned, rented, or personally owned vehicles.

## **H.7 ANNUAL AND FINAL CONTRACTOR PERFORMANCE EVALUATIONS**

Annual and final evaluations of contractor performance under this contract will be prepared in accordance with FAR 42.15, "Contractor Performance Information," normally at the time the contractor is notified of the NRC's intent to exercise the contract option. If the multi-year contract does not have option years, then an annual evaluation will be prepared (state time for annual evaluation). Final evaluations of contractor performance will be prepared at the expiration of the contract during the contract closeout process.

The Contracting Officer will transmit the NRC Project Officer's annual and final contractor performance evaluations to the contractor's Project Manager, unless otherwise instructed by the contractor. The contractor will be permitted thirty days to review the document. The contractor may concur without comment, submit additional information, or request a meeting to discuss the performance evaluation. The Contracting Officer may request the contractor's Project Manager to attend a meeting to discuss the performance evaluation.

Where a contractor concurs with, or takes no exception to an annual performance evaluation, the Contracting Officer will consider such evaluation final and releasable for source selection purposes. Disagreements between the parties regarding a performance evaluation will be referred to an individual one level above the Contracting Officer, whose decision will be final.

The Contracting Officer will send a copy of the completed evaluation report, marked "For Official Use Only," to the contractor's Project Manager for their records as soon as practicable after it has been finalized. The completed evaluation report also will be used as a tool to improve communications between the NRC and the contractor and to improve contract performance.

The completed annual performance evaluation will be used to support future award decisions in accordance with FAR 42.1502(a) and 42.1503(c). During the period the information is being used to provide source selection information, the completed annual performance evaluation will be released to only two parties - the Federal government personnel performing the source selection evaluation and the contractor under evaluation if the contractor does not have a copy of the report already.

## **H.8 WHISTLEBLOWER PROTECTION FOR NRC CONTRACTOR AND SUBCONTRACTOR EMPLOYEES (JULY 2006)**

(a) The U.S. Nuclear Regulatory Commission (NRC) contractor and its subcontractor are subject to the Whistleblower Employee Protection public law provisions as codified at 42 U.S.C. 5851. NRC contractor(s) and subcontractor(s) shall comply with the requirements of this Whistleblower Employee Protection law, and the implementing regulations of the NRC and the Department of Labor (DOL). See, for example, DOL Procedures on Handling Complaints at 29 C.F.R. Part 24 concerning the employer obligations, prohibited acts, DOL procedures and the requirement for prominent posting of notice of Employee Rights at Appendix A to Part 24.

(b) Under this Whistleblower Employee Protection law, as implemented by regulations, NRC contractor and subcontractor employees are protected from discharge, reprisal, threats, intimidation, coercion, blacklisting or other employment discrimination practices with respect to compensation, terms, conditions or privileges of their employment because the contractor or subcontractor employee(s) has provided notice to the employer, refused to engage in unlawful practices, assisted in proceedings or testified on activities concerning alleged violations of the Atomic Energy Act of 1954 (as amended) and the Energy Reorganization Act of 1974 (as amended).

(c) The contractor shall insert this or the substance of this clause in any subcontracts involving work performed under this contract.

**PART II - CONTRACT CLAUSES****SECTION I - CONTRACT CLAUSES****I.1 NOTICE LISTING CONTRACT CLAUSES INCORPORATED BY REFERENCE**

The following contract clauses pertinent to this section are hereby incorporated by reference (by Citation Number, Title, and Date) in accordance with the clause at FAR "52.252-2 CLAUSES INCORPORATED BY REFERENCE" in Section I of this contract. See FAR 52.252-2 for an internet address (if specified) for electronic access to the full text of a clause.

NUMBER	TITLE	DATE
	FEDERAL ACQUISITION REGULATION (48 CFR Chapter 1)	
52.202-1	DEFINITIONS	JUL 2004
52.203-3	GRATUITIES	APR 1984
52.203-5	COVENANT AGAINST CONTINGENT FEES	APR 1984
52.203-7	ANTI-KICKBACK PROCEDURES	JUL 1995
52.203-8	CANCELLATION, RESCISSION, AND RECOVERY OF FUNDS FOR ILLEGAL OR IMPROPER ACTIVITY	JAN 1997
52.203-10	PRICE OR FEE ADJUSTMENT FOR ILLEGAL OR IMPROPER ACTIVITY	JAN 1997
52.203-12	LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS	SEP 2007
52.204-4	PRINTED OR COPIED DOUBLE-SIDED ON RECYCLED PAPER	AUG 2000
52.204-7	CENTRAL CONTRACTOR REGISTRATION	APR 2008
52.209-6	PROTECTING THE GOVERNMENT'S INTEREST WHEN SUBCONTRACTING WITH CONTRACTORS DEBARRED, SUSPENDED, OR PROPOSED FOR DEBARMENT	SEP 2006
52.215-2	AUDIT AND RECORDS--NEGOTIATION ALTERNATE II (APR 1998)	JUN 1999
52.215-8	ORDER OF PRECEDENCE--UNIFORM CONTRACT FORMAT	OCT 1997
52.216-11	COST CONTRACT--NO FEE ALTERNATE I (APR 1984)	APR 1984
52.215-10	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA	OCT 1997
52.215-12	SUBCONTRACTOR COST OR PRICING DATA	OCT 1997
52.215-15	PENSION ADJUSTMENTS AND ASSET REVERSIONS (JAN 2004)	OCT 2004
52.215-18	REVERSION OR ADJUSTMENT OF PLANS FOR POSTRETIREMENT BENEFITS OTHER THAN PENSIONS (PRB)	JUL 2005
52.215-19	NOTIFICATION OF OWNERSHIP CHANGES	OCT 1997
52.219-8	UTILIZATION OF SMALL BUSINESS CONCERNS	MAY 2004
52.222-3	CONVICT LABOR	JUN 2003
52.222-21	PROHIBITION OF SEGREGATED FACILITIES	FEB 1999

52.222-26	EQUAL OPPORTUNITY	MAR 2007
52.222-35	EQUAL OPPORTUNITY FOR SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS	SEP 2006
52.222-36	AFFIRMATIVE ACTION FOR WORKERS WITH DISABILITIES	JUN 1998
52.222-37	EMPLOYMENT REPORTS ON SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS	SEP 2006
52.222-50	COMBATING TRAFFICKING IN PERSONS	FEB 2009
52.223-6	DRUG-FREE WORKPLACE	MAY 2001
52.225-13	RESTRICTIONS ON CERTAIN FOREIGN PURCHASES	JUN 2008
52.227-1A	AUTHORIZATION AND CONSENT ALTERNATE I (APR 1984)	DEC 2007
52.227-2	NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT	DEC 2007
52.227-14	RIGHTS IN DATA--GENERAL	DEC 2007
52.228-7	INSURANCE--LIABILITY TO THIRD PERSONS	MAR 1996
52.232-18	AVAILABILITY OF FUNDS	APR 1984
52.232-22	LIMITATION OF FUNDS	APR 1984
52.232-23	ASSIGNMENT OF CLAIMS	JAN 1986
52.232-25	PROMPT PAYMENT	OCT 2008
52.232-33	PAYMENT BY ELECTRONIC FUNDS--CENTRAL CONTRACTOR REGISTRATION	OCT 2003
52.233-1	DISPUTES	JUL 2002
52.233-3	PROTEST AFTER AWARD ALTERNATE I (JUN 1985)	AUG 1996
52.233-4	APPLICABLE LAW FOR BREACH OF CONTRACT CLAIM	OCT 2004
52.242-1	NOTICE OF INTENT TO DISALLOW COSTS	APR 1984
52.242-3	PENALTIES FOR UNALLOWABLE COSTS	MAY 2001
52.242-13	BANKRUPTCY	JUL 1995
52.243-2	CHANGES--COST REIMBURSEMENT ALTERNATE V (APR 1984)	AUG 1987
52.244-2A	SUBCONTRACTS ALTERNATE I (JUNE 2007)	JUN 2007
52.244-5	COMPETITION IN SUBCONTRACTING	DEC 1996
52.244-6	SUBCONTRACTS FOR COMMERCIAL ITEMS	MAR 2009
52.245-1B	GOVERNMENT PROPERTY ALTERNATE II (JUNE 2007)	JUN 2007
52.245-9	USE AND CHARGES	JUN 2007
52.246-23	LIMITATION OF LIABILITY	FEB 1997
52.249-5	TERMINATION FOR CONVENIENCE OF THE GOVERNMENT (EDUCATIONAL AND OTHER NONPROFIT INSTITUTIONS)	SEP 1996
52.253-1	COMPUTER GENERATED FORMS	JAN 1991

## I.2 52.216-7 ALLOWABLE COST AND PAYMENT (DEC 2002)

(a) Invoicing.

(1) The Government will make payments to the Contractor when requested as work progresses, but (except for small business concerns) not more often than once every 2 weeks, in amounts determined to be allowable by the Contracting Officer in accordance with Federal Acquisition Regulation (FAR) Subpart 31.3 in effect on the date of this contract and the terms of this contract. The Contractor may submit to an authorized representative of the Contracting Officer, in such form and reasonable detail as the representative may require, an invoice or voucher supported by a statement of the claimed allowable cost for performing this contract.

(2) Contract financing payments are not subject to the interest penalty provisions of the Prompt Payment Act. Interim payments made prior to the final payment under the contract are contract financing payments, except interim payments if this contract contains Alternate I to the clause at 52.232-25.

(3) The designated payment office will make interim payments for contract financing on the 30th day after the designated billing office receives a proper payment request.

In the event that the Government requires an audit or other review of a specific payment request to ensure compliance with the terms and conditions of the contract, the designated payment office is not compelled to make payment by the specified due date.

(b) Reimbursing costs.

(1) For the purpose of reimbursing allowable costs (except as provided in paragraph (b)(2) of the clause, with respect to pension, deferred profit sharing, and employee stock ownership plan contributions), the term "costs" includes only--

(i) Those recorded costs that, at the time of the request for reimbursement, the Contractor has paid by cash, check, or other form of actual payment for items or services purchased directly for the contract;

(ii) When the Contractor is not delinquent in paying costs of contract performance in the ordinary course of business, costs incurred, but not necessarily paid, for--

(A) Supplies and services purchased directly for the contract and associated financing payments to subcontractors, provided payments determined due will be made--

(1) In accordance with the terms and conditions of a subcontract or invoice; and

(2) Ordinarily within 30 days of the submission of the Contractor's payment request to the Government;

(B) Materials issued from the Contractor's inventory and placed in the production process for use on the contract;

(C) Direct labor;

(D) Direct travel;

(E) Other direct in-house costs; and

(F) Properly allocable and allowable indirect costs, as shown in the records maintained by the Contractor for purposes of obtaining reimbursement under Government contracts; and

(iii) The amount of financing payments that have been paid by cash, check, or other forms of payment to subcontractors.

(2) Accrued costs of Contractor contributions under employee pension plans shall be excluded until actually paid unless--

(i) The Contractor's practice is to make contributions to the retirement fund quarterly or more frequently; and

(ii) The contribution does not remain unpaid 30 days after the end of the applicable quarter or shorter payment period (any contribution remaining unpaid shall be excluded from the Contractor's indirect costs for payment purposes).

(3) Notwithstanding the audit and adjustment of invoices or vouchers under paragraph (g) of this clause, allowable indirect costs under this contract shall be obtained by applying indirect cost rates established in accordance with paragraph (d) of this clause.

(4) Any statements in specifications or other documents incorporated in this contract by reference designating performance of services or furnishing of materials at the Contractor's expense or at no cost to the Government shall be disregarded for purposes of cost-reimbursement under this clause.

(c) Small business concerns. A small business concern may receive more frequent payments than every 2 weeks.

(d) Final indirect cost rates.

(1) Final annual indirect cost rates and the appropriate bases shall be established in accordance with Subpart 42.7 of the Federal Acquisition Regulation (FAR) in effect for the period covered by the indirect cost rate proposal.

(2)(i) The Contractor shall submit an adequate final indirect cost rate proposal to the Contracting Officer (or cognizant Federal agency official) and auditor within the 6-month period following the expiration of each of its fiscal years. Reasonable extensions, for exceptional circumstances only, may be requested in writing by the Contractor and granted in writing by the Contracting Officer. The Contractor shall support its proposal with adequate supporting data.

(ii) The proposed rates shall be based on the Contractor's actual cost experience for that period. The appropriate Government representative and the Contractor shall establish the final indirect cost rates as promptly as practical after receipt of the Contractor's proposal.

(3) The Contractor and the appropriate Government representative shall execute a written understanding setting forth the final indirect cost rates. The understanding shall specify (i) the agreed-upon final annual indirect cost rates, (ii) the bases to which the rates apply, (iii) the periods for which the rates apply, (iv) any specific indirect cost items treated as direct costs in the settlement, and (v) the affected contract and/or subcontract, identifying any with advance agreements or special terms and the applicable rates. The understanding shall not change any monetary ceiling, contract obligation, or specific cost allowance or disallowance provided for in this contract. The understanding is incorporated into this contract upon execution.

(4) Failure by the parties to agree on a final annual indirect cost rate shall be a dispute within the meaning of the Disputes clause.

(5) Within 120 days (or longer period if approved in writing by the Contracting Officer) after settlement of the final annual indirect cost rates for all years of a physically complete contract, the Contractor shall submit a completion invoice or voucher to reflect the settled amounts and rates.

(6)(i) If the Contractor fails to submit a completion invoice or voucher within the time specified in paragraph (d)(5) of this clause, the Contracting Officer may--

(A) Determine the amounts due to the Contractor under the contract; and

(B) Record this determination in a unilateral modification to the contract.

(ii) This determination constitutes the final decision of the Contracting Officer in accordance with the Disputes clause.

(e) Billing rates. Until final annual indirect cost rates are established for any period, the Government shall reimburse the Contractor at billing rates established by the Contracting Officer or by an authorized representative (the cognizant auditor), subject to adjustment when the final rates are established. These billing rates--

(1) Shall be the anticipated final rates; and

(2) May be prospectively or retroactively revised by mutual agreement, at either party's request, to prevent substantial overpayment or underpayment.

(f) Quick-closeout procedures. Quick-closeout procedures are applicable when the conditions in FAR 42.708(a) are satisfied.

(g) Audit. At any time or times before final payment, the Contracting Officer may have the Contractor's invoices or vouchers and statements of cost audited. Any payment may be (1) reduced by amounts found by the Contracting Officer not to constitute allowable costs or (2) adjusted for prior overpayments or underpayments.

(h) Final payment. (1) Upon approval of a completion invoice or voucher submitted by the Contractor in accordance with paragraph (d)(5) of this clause, and upon the Contractor's compliance with all terms of this contract, the Government shall promptly pay any balance of allowable costs and that part of the fee (if any) not previously paid.

(2) The Contractor shall pay to the Government any refunds, rebates, credits, or other amounts (including interest, if any) accruing to or received by the Contractor or any assignee under this contract, to the extent that those amounts are properly allocable to costs for which the Contractor has been reimbursed by the Government. Reasonable expenses incurred by the Contractor for securing refunds, rebates, credits, or other amounts shall be allowable costs if approved by the Contracting Officer. Before final payment under this contract, the Contractor and each assignee whose assignment is in effect at the time of final payment shall execute and deliver--

(i) An assignment to the Government, in form and substance satisfactory to the Contracting Officer, of refunds, rebates, credits, or other amounts (including interest, if any) properly allocable to costs for which the Contractor has been reimbursed by the Government under this contract; and

(ii) A release discharging the Government, its officers, agents, and employees from all liabilities, obligations, and claims arising out of or under this contract, except--

(A) Specified claims stated in exact amounts, or in estimated amounts when the exact amounts are not known;

(B) Claims (including reasonable incidental expenses) based upon liabilities of the Contractor to third parties arising out of the performance of this contract; provided, that the claims are not known to the Contractor on the date of the execution of the release, and that the Contractor gives notice of the claims in writing to the Contracting Officer within 6 years following the release date or notice of final payment date, whichever is earlier; and

(C) Claims for reimbursement of costs, including reasonable incidental expenses, incurred by the Contractor under the patent clauses of this contract, excluding, however, any expenses arising from the Contractor's indemnification of the Government against patent liability.

### **I.3 52.219-28 POST-AWARD SMALL BUSINESS PROGRAM REREPRESENTATION (APR 2009)**

(a) Definitions. As used in this clause-

Long-term contract means a contract of more than five years in duration, including options. However, the term does not include contracts that exceed five years in duration because the period of performance has been extended for a cumulative period not to exceed six months under the clause at 52.217-8, Option to Extend Services, or other appropriate authority.

Small business concern means a concern, including its affiliates, that is independently owned and operated, not dominant in the field of operation in which it is bidding on Government contracts, and qualified as a small business under the criteria in 13 CFR part 121 and the size standard in paragraph (c) of this clause. Such a concern is "not dominant in its field of operation" when it does not exercise a controlling or major influence on a national basis in a kind of business activity in which a number of business concerns are primarily engaged. In determining whether dominance exists, consideration shall be given to all appropriate factors, including volume of business, number of employees, financial resources, competitive status or position, ownership or control of materials, processes, patents, license agreements, facilities, sales territory, and nature of business activity.

(b) If the Contractor represented that it was a small business concern prior to award of this contract, the Contractor shall rerepresent its size status according to paragraph (e) of this clause or, if applicable, paragraph (g) of this clause, upon the occurrence of any of the following:

(1) Within 30 days after execution of a novation agreement or within 30 days after modification of the contract to include this clause, if the novation agreement was executed prior to inclusion of this clause in the contract.

(2) Within 30 days after a merger or acquisition that does not require a novation or within 30 days after modification of the contract to include this clause, if the merger or acquisition occurred prior to inclusion of this clause in the contract.

(3) For long-term contracts-

(i) Within 60 to 120 days prior to the end of the fifth year of the contract; and

(ii) Within 60 to 120 days prior to the date specified in the contract for exercising any option thereafter.

(c) The Contractor shall represent its size status in accordance with the size standard in effect at the time of this representation that corresponds to the North American Industry Classification System (NAICS) code assigned to this contract. The small business size standard corresponding to this NAICS code can be found at <http://www.sba.gov/services/contractingopportunities/sizestandardsttopics/>.

(d) The small business size standard for a Contractor providing a product which it does not manufacture itself, for a contract other than a construction or service contract, is 500 employees.

(e) Except as provided in paragraph (g) of this clause, the Contractor shall make the representation required by paragraph (b) of this clause by validating or updating all its representations in the Online Representations and Certifications Application and its data in the Central Contractor Registration, as necessary, to ensure that they reflect the Contractor's current status. The Contractor shall notify the contracting office in writing within the

timeframes specified in paragraph (b) of this clause that the data have been validated or updated, and provide the date of the validation or update.

(f) If the Contractor represented that it was other than a small business concern prior to award of this contract, the Contractor may, but is not required to, take the actions required by paragraphs (e) or (g) of this clause.

(g) If the Contractor does not have representations and certifications in ORCA, or does not have a representation in ORCA for the NAICS code applicable to this contract, the Contractor is required to complete the following representation and submit it to the contracting office, along with the contract number and the date on which the representation was completed:

The Contractor represents that it [ ] is, [x] is not a small business concern under NAICS Code 541990 assigned to contract number NRC-04-09-125.

#### **I.4 52.222-39 NOTIFICATION OF EMPLOYEE RIGHTS CONCERNING PAYMENT OF UNION DUES OR FEES (DEC 2004)**

(a) Definition. As used in this clause--

"United States" means the 50 States, the District of Columbia, Puerto Rico, the Northern Mariana Islands, American Samoa, Guam, the U.S. Virgin Islands, and Wake Island.

(b) Except as provided in paragraph (e) of this clause, during the term of this contract, the Contractor shall post a notice, in the form of a poster, informing employees of their rights concerning union membership and payment of union dues and fees, in conspicuous places in and about all its plants and offices, including all places where notices to employees are customarily posted. The notice shall include the following information (except that the information pertaining to National Labor Relations Board shall not be included in notices posted in the plants or offices of carriers subject to the Railway Labor Act, as amended (45 U.S.C. 151-188)).

##### Notice to Employees

Under Federal law, employees cannot be required to join a union or maintain membership in a union in order to retain their jobs. Under certain conditions, the law permits a union and an employer to enter into a union-security agreement requiring employees to pay uniform periodic dues and initiation fees. However, employees who are not union members can object to the use of their payments for certain purposes and can only be required to pay their share of union costs relating to collective bargaining, contract administration, and grievance adjustment.

If you do not want to pay that portion of dues or fees used to support activities not related to collective bargaining, contract administration, or grievance adjustment, you are entitled to an appropriate reduction in your payment. If you believe that you have been required to pay dues or fees used in part to support activities not related to collective bargaining, contract administration, or grievance adjustment, you may be entitled to a refund and to an appropriate reduction in future payments.

For further information concerning your rights, you may wish to contact the National Labor Relations Board (NLRB) either at one of its Regional offices or at the following address or toll free number:

National Labor Relations Board  
Division of Information  
1099 14th Street, N.W.  
Washington, DC 20570

1-866-667-6572  
1-866-316-6572 (TTY)

To locate the nearest NLRB office, see NLRB's website at <http://www.nlr.gov>.

(c) The Contractor shall comply with all provisions of Executive Order 13201 of February 17, 2001, and related implementing regulations at 29 CFR Part 470, and orders of the Secretary of Labor.

(d) In the event that the Contractor does not comply with any of the requirements set forth in paragraphs (b), (c), or (g), the Secretary may direct that this contract be cancelled, terminated, or suspended in whole or in part, and declare the Contractor ineligible for further Government contracts in accordance with procedures at 29 CFR Part 470, Subpart B--Compliance Evaluations, Complaint Investigations and Enforcement Procedures. Such other sanctions or remedies may be imposed as are provided by 29 CFR Part 470, which implements Executive Order 13201, or as are otherwise provided by law.

(e) The requirement to post the employee notice in paragraph (b) does not apply to--

(1) Contractors and subcontractors that employ fewer than 15 persons;

(2) Contractor establishments or construction work sites where no union has been formally recognized by the Contractor or certified as the exclusive bargaining representative of the Contractor's employees;

(3) Contractor establishments or construction work sites located in a jurisdiction named in the definition of the United States in which the law of that jurisdiction forbids enforcement of union-security agreements;

(4) Contractor facilities where upon the written request of the Contractor, the Department of Labor Deputy Assistant Secretary for Labor-Management Programs has waived the posting requirements with respect to any of the Contractor's facilities if the Deputy Assistant Secretary finds that the Contractor has demonstrated that--

(i) The facility is in all respects separate and distinct from activities of the Contractor related to the performance of a contract; and

(ii) Such a waiver will not interfere with or impede the effectuation of the Executive order; or

(5) Work outside the United States that does not involve the recruitment or employment of workers within the United States.

(f) The Department of Labor publishes the official employee notice in two variations; one for contractors covered by the Railway Labor Act and a second for all other contractors. The Contractor shall--

(1) Obtain the required employee notice poster from the Division of Interpretations and Standards, Office of Labor-Management Standards, U.S. Department of Labor, 200 Constitution Avenue, NW, Room N-5605, Washington, DC 20210, or from any field office of the Department's Office of Labor-Management Standards or Office of Federal Contract Compliance Programs;

(2) Download a copy of the poster from the Office of Labor- Management Standards website at <http://www.olms.dol.gov>; or

(3) Reproduce and use exact duplicate copies of the Department of Labor's official poster.

(g) The Contractor shall include the substance of this clause in every subcontract or purchase order that exceeds the simplified acquisition threshold, entered into in connection with this contract, unless exempted by the Department of Labor Deputy Assistant Secretary for Labor-Management Programs on account of special circumstances in the national interest under authority of 29 CFR 470.3(c). For indefinite quantity subcontracts,

the Contractor shall include the substance of this clause if the value of orders in any calendar year of the subcontract is expected to exceed the simplified acquisition threshold. Pursuant to 29 CFR Part 470, Subpart B--Compliance Evaluations, Complaint Investigations and Enforcement Procedures, the Secretary of Labor may direct the Contractor to take such action in the enforcement of these regulations, including the imposition of sanctions for noncompliance with respect to any such subcontract or purchase order. If the Contractor becomes involved in litigation with a subcontractor or vendor, or is threatened with such involvement, as a result of such direction, the Contractor may request the United States, through the Secretary of Labor, to enter into such litigation to protect the interests of the United States.

### **I.5 52.249-14 EXCUSABLE DELAYS (APR 1984)**

(a) Except for defaults of subcontractors at any tier, the Contractor shall not be in default because of any failure to perform this contract under its terms if the failure arises from causes beyond the control and without the fault or negligence of the Contractor. Examples of these causes are (1) acts of God or of the public enemy, (2) acts of the Government in either its sovereign or contractual capacity, (3) fires, (4) floods, (5) epidemics, (6) quarantine restrictions, (7) strikes, (8) freight embargoes, and (9) unusually severe weather. In each instance, the failure to perform must be beyond the control and without the fault or negligence of the Contractor. "Default" includes failure to make progress in the work so as to endanger performance.

(b) If the failure to perform is caused by the failure of a subcontractor at any tier to perform or make progress, and if the cause of the failure was beyond the control of both the Contractor and subcontractor, and without the fault or negligence of either, the Contractor shall not be deemed to be in default, unless--

(1) The subcontracted supplies or services were obtainable from other sources;

(2) The Contracting Officer ordered the Contractor in writing to purchase these supplies or services from the other source; and

(3) The Contractor failed to comply reasonably with this order.

(c) Upon request of the Contractor, the Contracting Officer shall ascertain the facts and extent of the failure. If the Contracting Officer determines that any failure to perform results from one or more of the causes above, the delivery schedule shall be revised, subject to the rights of the Government under the termination clause of this contract.

### **I.6 52.217-8 OPTION TO EXTEND SERVICES (NOV 1999)**

The Government may require continued performance of any services within the limits and at the rates specified in the contract. These rates may be adjusted only as a result of revisions to prevailing labor rates provided by the Secretary of Labor. The option provision may be exercised more than once, but the total extension of performance hereunder shall not exceed 6 months. The Contracting Officer may exercise the option by written notice to the Contractor within 30 days..

### **I.7 52.252-2 CLAUSES INCORPORATED BY REFERENCE (FEB 1998)**

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):

<http://www.arnet.gov/far>

**PART III - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACHMENTS**

**SECTION J - LIST OF ATTACHMENTS**

ATTACHMENT  
NUMBER

TITLE

1

Billing Instructions for Cost Reimbursement Contracts

BILLING INSTRUCTIONS FOR  
COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)

**General:** During performance and through final payment of this contract, the contractor is responsible for the accuracy and completeness of data within the Central Contractor Registration (CCR) database and for any liability resulting from the Government's reliance on inaccurate or incomplete CCR data.

The contractor shall prepare vouchers/invoices for reimbursement of costs in the manner and format described herein. FAILURE TO SUBMIT VOUCHERS/INVOICES IN ACCORDANCE WITH THESE INSTRUCTIONS WILL RESULT IN REJECTION OF THE VOUCHER/INVOICE AS IMPROPER.

**Number of Copies:** A signed original and supporting documentation shall be submitted. If the voucher/invoice includes the purchase of any property with an initial acquisition cost of \$50,000 or more, a copy of the signed original is also required.

**Designated Agency Billing Office:** The preferred method of submitting vouchers/invoices is electronically to the Department of the Interior at [NRCPayments@nbc.gov](mailto:NRCPayments@nbc.gov)

If the voucher/invoice includes the purchase of capital property with an initial acquisition cost of \$50,000 or more, a copy of the signed original shall be electronically sent to: [Property@nrc.gov](mailto:Property@nrc.gov)

However, if you submit a hard-copy of the voucher/invoice, it shall be submitted to the following address:

Department of the Interior  
National Business Center  
Attn: Fiscal Services Branch - D2770  
7301 West Mansfield Avenue  
Denver, CO 80235-2230

If you submit a hard-copy of the voucher/invoice and it includes the purchase of capital property with an initial acquisition cost of \$50,000 or more, a copy of the signed original shall be mailed to the following address:

U.S. Nuclear Regulatory Commission  
NRC Property Management Officer  
Mail Stop: O-4D15  
Washington, DC 20555-0001

HAND-CARRIED SUBMISSIONS WILL NOT BE ACCEPTED

**Agency Payment Office:** Payment will continue to be made by the office designated in the contract in Block 12 of the Standard Form 26, or Block 25 of the Standard Form 33, whichever is applicable.

BILLING INSTRUCTIONS FOR  
COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)

**Frequency:** The contractor shall submit claims for reimbursement once each month, unless otherwise authorized by the Contracting Officer.

**Format:** Claims shall be submitted in the format depicted on the attached sample form entitled "Voucher/Invoice for Purchases and Services Other than Personal" (see Attachment 1). The sample format is provided for guidance only. The format is not required for submission of a voucher/invoice. Alternate formats are permissible provided all requirements of the billing instructions are addressed. The instructions for preparation and itemization of the voucher/invoice are included with the sample form.

**Task Ordering Contracts:** If the contractor bills for more than one task order under a voucher/invoice, detailed cost information for each individual task order shall be submitted, together with a cumulative summary of all charges billed on the voucher/invoice. This includes all applicable cost elements discussed in paragraphs (a) through (n) of the attached instructions.

**Fee Recovery Billings:** Pursuant to the provisions of 10 CFR Part 170 and 171 on license fees, the NRC must recover the cost of work performed. Accordingly, the contractor must provide the total amount of funds billed during the period, fiscal year to date and the cumulative total for each task or task assignment by facility or report. The fee recovery billing reports shall be on a separate page, and shall be in the format provided (see Attachment 1). The billing period for fee recovery costs should be from the first day of each calendar month to the last day of the same month. Each separate fee billing report must be attached to the monthly invoice and cover the same period as the invoice.

Each report will contain a docket number or other unique identifier. The NRC will provide a unique identifier for all work performed. Costs should be reported as whole number to the nearest cent. For work that involves more than one facility at the same site, each facility should be listed separately and the costs should be split appropriately between the facilities. Common costs, as defined below, shall be identified as a separate line item in the fee recovery billing report each month.

Common costs are those costs that are not licensee unique and associated with the performance of an overall program that benefit all similar licensees covered under that program or that are required to satisfactorily carry out the program. Common costs include costs associated with the following: preparatory or start-up efforts to interpret and reach agreement on methodology, approach, acceptance criteria, regulatory position, or technical reporting requirements; efforts associated with the "lead plant" concept that might be involved during the first one or two plant reviews; meetings and discussions involving the above efforts to provide orientation, background knowledge or guidance during the course of a program; any technical effort applied to a docket or other unique identifier; and project management. Common costs must be reporting monthly for each docket or unique identifier. Common costs must be computed based on the proportion of direct costs incurred against each docket or unique identifier for the billing period.

BILLING INSTRUCTIONS FOR  
COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)

**Billing of Cost after Expiration of Contract:** If costs are incurred during the contract period and claimed after the contract has expired, you must cite the period during which these costs were incurred. To be considered a proper expiration voucher/invoice, the contractor shall clearly mark it "EXPIRATION VOUCHER" or "EXPIRATION INVOICE":

Final vouchers/invoices shall be marked "FINAL VOUCHER" or "FINAL INVOICE".

**Currency:** Billings may be expressed in the currency normally used by the contractor in maintaining his accounting records and payments will be made in that currency. However, the U.S. dollar equivalent for all vouchers/invoices paid under the contract may not exceed the total U.S. dollars authorized in the contract.

Supersession: These instructions supersede any previous billing instructions.

R:\txselden\billing instructions CR revised 2008

(SAMPLE FORMAT)

COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)  
INVOICE/ VOUCHER FOR PURCHASES AND SERVICES OTHER THAN PERSONAL

**1. Official Agency Billing Office**

Department of the Interior  
National Business Center  
Attn: Fiscal Services Branch - D2770  
7301 West Mansfield Avenue  
Denver, CO 80235-2230

**2. Voucher Information**

- a. Payee's DUNS Number or DUNS+4. The Payee shall include the Payee's Data Universal Number (DUNS) or DUNS+4 number that identifies the Payee's name and address. The DUNS+4 number is the DUNS number plus a 4-character suffix that may be assigned at the discretion of the Payee to identify alternative Electronic Funds Transfer (EFT) accounts for the same parent concern.
- b. Payee's Name and Address. Show the name of the Payee as it appears in the contract and its correct address. If the Payee assigns the proceeds of this contract as provided for in the assignment of claims terms of this contract, the Payee shall require as a condition of any such assignment, that the assignee shall register separately in the Central Contractor Registration (CCR) database at <http://www.ccr.gov> and shall be paid by EFT in accordance with the terms of this contract. See Federal Acquisition Regulation 52.232-33(g) Payment by Electronic Funds Transfer - Central Contractor Registration (October 2003).
- c. Contract Number. Insert the NRC contract number.  
Task Order No. Insert the task order number (If Applicable).
- d. Voucher/Invoice. The appropriate sequential number of the voucher/invoice, beginning with 001 should be designated. Contractors may also include an individual internal accounting number, if desired, in addition to the 3-digit sequential number.
- e. Date of Voucher/Invoice. Insert the date the voucher/invoice is prepared.
- f. Billing period. Insert the beginning and ending dates (day, month, year) of the period during which costs were incurred and for which reimbursement is claimed.
- g. Direct Costs - Insert the amount billed for the following cost elements, adjustments, suspensions, and total amounts, for both the current billing period and for the cumulative period (from contract inception to end date of this billing period).

- (1) Direct Labor. This consists of salaries and wages paid (or accrued) for direct performance of the contract itemized as follows:

<u>Labor</u>	<u>Hrs.</u>			<u>Cumulative</u>
<u>Category</u>	<u>Billed</u>	<u>Rate</u>	<u>Total</u>	<u>Hrs.Billed</u>

(SAMPLE FORMAT)

COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)  
INVOICE/ VOUCHER FOR PURCHASES AND SERVICES OTHER THAN PERSONAL

- (2) Fringe Benefits. This represents fringe benefits applicable to direct labor and billed as a direct cost. Where a rate is used indicate the rate. Fringe benefits included in direct labor or in other indirect cost pools should not be identified here.
- (3) Capitalized Non Expendable Equipment. List each item costing \$50,000 or more and having a life expectancy of more than one year. List only those items of equipment for which reimbursement is requested. For each such item, list the following (as applicable): (a) the item number for the specific piece of equipment listed in the property schedule of the contract; or (b) the Contracting Officer's approval letter if the equipment is not covered by the property schedule.
- (4) Non-capitalized Equipment, Materials, and Supplies. These are equipment other than that described in (3) above, plus consumable materials, supplies. List by category. List items valued at \$1,000 or more separately. Provide the item number for each piece of equipment valued at \$1,000 or more.
- (5) Premium Pay. This enumeration in excess of the basic hourly rate. (Requires written approval of the Contracting Officer.)
- (6) Consultants. The supporting information must include the name, hourly or daily rate of the consultant, and reference the NRC approval (if not specifically approved in the original contract).
- (7) Travel. Total costs associated with each trip must be shown in the following format:

<u>Start Date</u>	<u>Destination</u>	<u>Costs</u>
From To	From To	\$

- (8) Subcontracts. Include separate detailed breakdown of all costs paid to approved subcontractors during the billing period.
- (9) Other Costs. List all other direct costs by cost element and dollar amount separately.
- h. Indirect Costs (Overhead and General and Administrative Expense). Cite the formula (rate and base) in effect in accordance with the terms of the contract, during the time the costs were incurred and for which reimbursement is claimed.
- i. Fixed Fee. If the contract provides for a fixed fee, it must be claimed as provided for by the contract. Cite the formula or method of computation. Include this information as it applies to individual task orders as well.

The contractor may bill for fixed fee only up to 85% of total fee.

(SAMPLE FORMAT)

COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)  
INVOICE/ VOUCHER FOR PURCHASES AND SERVICES OTHER THAN PERSONAL

- j. Total Amount Billed. Insert the total amounts claimed for the current and cumulative periods.
- k. Adjustments. For cumulative amount, include outstanding suspensions.
- l. Grand Totals.

Further itemization of vouchers/invoices shall only be required for items having specific limitations set forth in the contract.

**3. Sample Voucher Information**

This voucher represents reimbursable costs for the billing period from \_\_\_ through \_\_\_.

<u>Amount Billed</u>
<u>Current Period</u> <u>Cumulative</u>

- (a) Direct Costs
  - (1) Direct labor\*.....
  - (2) Fringe benefits ( % , if computed as percentage).....
  - (3) Capitalized non-expendable equipment (\$50,000 or more - see instructions)\*.....
  - (4) Non-capitalized equipment, materials, and supplies.....
  - (5) Premium pay (NRC approved overtime).....
  - (6) Consultants\*.....
  - (7) Travel\*.....
  - (8) Subcontracts\*.....
  - (9) Other costs\*.....

Total Direct Costs
- (b) Indirect Costs
  - (A) Overhead \_\_\_ % of \_\_\_\_\_(Indicate Base).....
- (c) Fixed-Fee (Cite Formula):
- (d) Total Amount Billed.....
- (e) Adjustments.....
- (f) Grand Totals.....

\* (Requires Supporting Information -- See Sample below)

**SAMPLE SUPPORTING INFORMATION**

(SAMPLE FORMAT)

COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)  
INVOICE/ VOUCHER FOR PURCHASES AND SERVICES OTHER THAN PERSONAL

1) Direct Labor - \$2400

<u>Labor Category</u>	<u>Hours</u>		<u>Cumulative</u>	
	<u>Billed</u>	<u>Rate</u>	<u>Total</u>	<u>Hrs. Billed</u>
Senior Engineer I	100	\$14.00	\$1400	975
Engineer	50	\$10.00	\$ 500	465
Computer Analyst	100	\$ 5.00	<u>\$ 500</u>	320
			\$2400	

3) Capitalized Non-Expendable Equipment

Prototype Spectrometer - item number 1000-01 \$60,000

4) Non-capitalized Equipment, Materials, and Supplies

10 Radon tubes @ \$110.00 = \$1100.00  
6 Pairs Electrostatic gloves @ \$150.00 = \$900.00  
\$2000.00

5) Premium Pay

Walter Murphy - 10 hours @ \$10.00 Per Hour = \$100  
(This was approved by NRC in letter dated 6/1/08)

6) Consultants' Fee

Dr. Carney - 1 hour @ \$100 = \$100

7) Travel

<u>Start Date</u>	<u>Destination</u>	<u>Costs</u>
6/1/08	Wash., DC	\$200

**4. FEE RECOVERY BILLING REPORT**

FIN:

Facility Name or Report Title:

TAC or Inspection Report Number:

(or other unique identifier)

Docket Number (if applicable):

Cost Categories	Period Amt.	Period Cost Incurred	Fiscal Year To Date Costs	Total Cumulative Costs
-----------------	-------------	----------------------	---------------------------	------------------------

Labor

(SAMPLE FORMAT)

COST REIMBURSEMENT TYPE CONTRACTS (JUNE 2008)  
INVOICE/ VOUCHER FOR PURCHASES AND SERVICES OTHER THAN PERSONAL

Materials

Subcontractor/  
Consultant

Travel

Other (specify)

Common Costs

Total

Remarks: